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# THE EMPIRE COTTON GROWING REVIEW

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THE
EMPIRE COTTON GROWING
REVIEW

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# COTTON-GROWING IN THE SOUTHERN SUDAN

BY

R. HEWISON.

IN a previous article an attempt was made to describe in genera terms the steps taken by the Sudan Government to extend the cultivation of cotton in the southern provinces of the Sudan. In that article it was indicated that in this effort to stimulate economic development in these regions, by encouraging the cultivation of cotton as a readily saleable cash crop, the Government had found itself faced with a series of minor problems, upon the solution of which the success of the venture depended. The object of the present article is to give some account of the various difficulties with which the authorities concerned were faced and of the means adopted to overcome them.

It is recognized that local problems in connection with cotton-growing vary in nature and magnitude in those many parts of the African continent in which the crop is receiving attention. As, however, we in the Sudan were able to benefit from what was known to have been done in other parts of Africa, it is hoped that some further description of our particular difficulties, the steps taken to overcome or avoid them, and the success attained, may be of interest and help to workers on similar lines elsewhere.

The problems encountered may be grouped under the two main headings, economic and agricultural.

ECONOMIC.—The most immediately pressing economic problem was that concerned with the price which the native cultivator would obtain when, in response to the advice and persuasion of the officials of the Government, he had grown a certain amount of cotton. Its local value, apart from the actual quality of the cotton itself, depended largely upon the facilities it was possible to provide for ginning and transport.

The question of the maintenance of quality will be dealt with in connection with agricultural problems.

In the previous article it was explained that trading in the ordinary sense is very limited throughout these provinces, and that such trade as there is, is mainly in the hands of petty native merchants from other districts, whose turnover is so small that in order to live at all they require a very high percentage of profit on individual transactions. The fall in cotton values, which coincided with the harvesting of the first considerable cotton crop in this region, made it quite impossible for traders of this class to obtain any such profits from dealings in cotton, if the cultivator was to receive a price for his crop that would repay him for the labour involved in its production, and also encourage him to continue and extend his efforts in the future. It was decided, therefore, that for the time being the Government must continue to take over the crop from the cultivator, and do the best possible in connection with its disposal.

A certain number of ginneries had been decided upon, and contracts were entered into for their supply and erection in the spring of 1926. The coal strike unfortunately delayed the delivery of machinery and structural steel, so that only one ginnery, of three definitely decided upon, was ready in time to deal with the crop of that season. This delay brought another complication into the problem, since it meant that the bulk of the crop must either be transported long distances in the seed, or left until the ginneries could be got ready. The latter alternative would have meant that considerable storage accommodation would have been required during the rains if damage to the cotton held over was to be prevented. It was decided, therefore, that the cotton should be transported to the nearest available ginnery, in spite of the extra cost entailed in carrying it as seed cotton. In fixing the price to be paid in the different districts, however, this extra cost of transport was disregarded. The figure eventually decided upon was that which it was considered the cotton would have been worth, in relation to Liverpool values, had ginning facilities been available in various local centres.

At the time this decision was made it appeared likely that a considerable loss to the Government would result. Since the whole scheme, however, was in the nature of an experiment in economic development, it was felt that the policy would be justified if it prevented any setback such as an unsatisfactory price would have produced. It is fortunate that the rise in cotton prices during the past summer has been sufficient to allow of the Government disposing of the crop with little or no loss on the whole transaction. It is likely that for some time to come the Sudan Government will have to continue the work of handling and financing the crop. As experience accumulates, however, and ginning and transport facilities are increased, the fixing of prices will become a simpler matter. By October in each year a fair estimate of what the total crop will be can be obtained. Further, it is possible to say by what dates the cotton can be delivered in Great Britain; the average premium which this cotton will command is also fairly well known now.

The price of future contracts for the months in which the various consignments can be put upon the Liverpool market, plus the premium obtainable, gives a valuation of the cotton. By hedging the whole or a proportion of the crop a definite value can therefore be fixed six months or more before the cotton is ready for disposal in Liverpool. From the figures arrived at in this way must be deducted the cost of ginning, transport by camel or motor-lorry, railways, and steamers in the Sudan, sea freight, handling and sale on this side. A fair price to the cultivator can therefore be arrived at before the cotton season really starts. In settling the amount to be actually paid to the cultivator, the cost of seed issued has to be taken into account, as also any taxes to which he may be liable in connection with his cotton cultivation. Selected seed is issued at the sowing season, and no cash payment is insisted upon then. A considerable proportion of the cost of seed issued up to date has not been recovered. It is intended, however, that when the prices paid to cultivators are established on a proper basis, a seed levy, calculated to cover the actual cost of the seed, shall be collected on cotton brought into the markets. Any taxes due to the Government in respect of cotton cultivation will also be collected in the same way—viz., a levy of so much per kantar (100 lbs. seed cotton).

*Ginneries.*—It was early recognized that the policy of the Government involved the provision by some means or other of ginning facilities. While cotton worth something like a shilling a pound can stand considerable transport changes, seed worth six or seven pounds per ton in Great Britain comes into a very different category. In the case of the most favoured districts, cotton from the Southern Sudan has to be carried some 1,000 miles by railway, or by river steamer and railway, while for more distant centres transport by similar means of over 1,600 miles is involved. No good cotton-growing centre is less than about eighty miles from the river or railway, while one of the best districts is some 160 miles from either. As the lint represents only about one third of the weight of seed cotton, it is obvious that the separation of the lint from the seed should take place as near as is reasonably possible to the places where it is grown. Even where the transport of cotton seed is an economic proposition, the reduction in total bulk which is possible when the lint is pressed into bales, and the seed put up in sacks, makes local ginning a definite necessity.

The decision that the provision of ginneries was an essential feature of the scheme involved the settlement of two questions of policy. The first of these was whether the ginneries in these districts should be operated by private enterprise or by the Government. A very complete control of ginneries has been an established policy of the Sudan Government in the older cotton-growing districts. It is held that unless the authority concerned has very complete powers over the operation of ginneries, real control of the cotton crop through the seed is difficult, if not impossible. In the case of at least one insect pest in the Sudan—viz., the Pink Bollworm—measures of control depend very largely upon the way in which ginneries are controlled. It has been common experience, moreover, in various parts of the world, that ginneries are often operated with entire disregard to such important considerations, and, further, that regulations and byelaws regarding the mixing of grades, treatment and distribution of seed, etc., fail to provide a really effective remedy for this state of affairs. While, therefore, insufficient ginning facilities may be a definite restriction on cotton-growing, the irresponsible operation of ginneries may easily hamper its development quite as effectually. Any country attempting to push the cultivation of cotton should therefore exercise the utmost caution in connection with allowing the establishment of ginning interests, and facilities should only be granted to such individuals or corporations as are likely to co-operate whole-heartedly with the authorities in operating the ginneries for the welfare of the cotton-growing industry.

So impressed has the Sudan Government been with the importance of this question that the laws of the Sudan allow of no ginnery being erected or operated, except under licence from the Director of Agriculture and Forests. In fact for more than twenty years the only licences issued have been to a very responsible body, the Sudan

Plantations Syndicate, Ltd., the Government's partner and manager in the Gezira Irrigation Scheme.

It was decided, therefore, that in connection with cotton-growing in the Southern Sudan the ginneries should be provided and operated by the Government through the Department of Agriculture and Forests. This settled, it remained to decide whether roller or saw gins should be installed. Up till this time only the former had been in use in the Sudan. For long staple Egyptian cotton roller gins must be used, and the bulk of the cotton hitherto grown in the Sudan was of this variety. Therefore, although the output from roller gins is small when dealing with the American types grown in the Sudan, compared with that obtained with Egyptian, the shorter staple cottons had also been ginned by roller gins. It was known that similar cottons in the United States were ginned by saw gins, and results obtained in Peru with the substitution of saw gins for rollers for cotton of longer staple than our American had pointed to the advisability of testing saw ginning for such cottons. A gin was therefore installed, and the experiments carried out showed that our American cotton could be dealt with by the saw gin without detriment to the staple.

One of the difficulties in connection with roller ginning in the Sudan is the supply of what are known as " gin carpenters." These men, whose function it is to make up the rollers and attend to the setting and running of the gins, are nearly all Egyptians. They proceed very largely by " rule of thumb " methods, but on the whole they are a fairly competent lot as far as technical skill and knowledge of ginning is required. They are, however, difficult people to manage, and when disgruntled in any way they can let down the standard of ginning in such a way as to seriously affect the value of the cotton. In Egypt, where they are in plentiful supply, they are difficult enough. But in the Sudan they are apt to be even more troublesome, relying on the knowledge that a substitute must be brought from Egypt, and that the ginning season is a short one. It was felt that in the southern provinces these difficulties would be increased by their fears of the climate, and other real or fancied dangers, and by the increased importance which lack of knowledge of ginning on the part of others would give them. It was decided, therefore, that saw gins should be adopted. For the larger units a battery of five seventy-saw gins, with pneumatic feed and delivery, was decided upon; the necessary power to be provided by means of gas engines, operating on gas from producers, utilizing cotton seed. The African type press, making a compact bale of

400 lbs., was chosen. The buildings were steel frame and galvanized sheeting, with ample provision for engine-room, mixing-room, and pressing floors. A workshop and store, also garage for motor-lorries, were incorporated in each ginnery. In designing these ginneries, great assistance was given by the British Cotton Growing Association, whose general plan of lay-out, with such improvements and modifications as experience had shown to be desirable, was adopted.

Three ginneries were completed during the 1926-27 season: at Torit in Mongalla Province, and Talodi and Kadugli in the Nuba Mountains Province. Further experience during that season has shown, however, that in Mongalla, at any rate, the large central ginnery would not meet all requirements. Centres of production are widely scattered and no position that would serve a sufficient number of these can be located at any convenient distance from the majority. As practically no domestic animals are kept in this province, there is an entire lack of local transport other than porters. It has been decided, therefore, to try the experiment of a smaller installation in three different districts. A unit consisting of three 40-saw gins, driven by a portable steam engine, and provided with a small press, has been chosen. These ginneries will be in operation in time to deal with this season's crop. Re-pressing of the ginned cotton will be necessary, in order to obtain a shipping bale; this can, however, be carried out at Makwar, which is on the railway. Whenever the production in a district outgrows the capacity of such an installation, it can be easily moved on to still more distant localities, and be replaced with a larger and more complete equipment capable of dealing with whatever crop is forthcoming.

*Transport.*—Last, but not by any means the least, of the economic problems to be discussed is that of transport.

As previously stated, there was very little in the shape of organized transport in any of these provinces when the attempt to extend cotton cultivation was started. In Mongalla Province a motor road had been constructed from Rejaf on the river Nile to the frontier of the Belgian Congo. Motor-lorries belonging to the Sudan Government and to a private trading organization operating chiefly in the Belgian Congo used this road. Only one cotton area, however, was served by it. Other roads have been made, or are being made, in this province, and both the Sudan Government and the trading concern referred to above have increased the numbers of their lorries in order to deal with the cotton traffic. In the Nuba

Mountains the northern districts were served to a certain extent by camel transport. An effort was made to develop this, with considerable success, last season. Not only was the whole of that season's cotton crop in seed carried to the railway, a distance of 160 miles, but, in addition, a considerable amount left over from the previous year was also transported by means of camels. As the ginnery will be in operation this year, and only lint will be transported, a very largely increased crop can be handled in future should the camels continue to come forward, and there is every sign that this will be the case. In actual cost, the transport by hired camels works out at something less than by motor-lorries, while there is no capital invested in the camels, by the Government at any rate, as there is in the case of motor-lorries. From the southern districts of this province, however, with Talodi as a centre, transport is dependent on the motor-lorries for the present, and there does not appear to be any likelihood of the camel ever undertaking any considerable part of this. A certain amount will be done in the way of transporting unginned cotton from smaller centres to the ginnery, for which work the camel is particularly suitable.

It is too early to make very definite estimates as to the real cost of transporting cotton, over such roads as exist in the Sudan, by motor-lorries. More experience is required as to the working life of the lorries and of the cost of upkeep and repairs under these conditions. The Railway Administration, however, who run the motor transport, regarding the motor routes as feeders to the main railway and steamer system, have arranged a general rate of 5 piastres (=1 shilling) per ton mile for cotton. As the longest regular haul is just 100 miles, the cost of carrying the cotton from the particular ginnery to the river port is £5 per ton. From ports on the river to Port Sudan, a through rate, varying on a zonal basis, has been arranged. At present an estimated figure for the cost of ginning has perforce to be used, but when a full season's running has been completed it should be possible to obtain definite costs for the different centres. With these, the figures for transport being already available, it will be possible to make a very accurate estimate of the expense involved in taking the cotton to the market, and so obtain the real value of the cotton at any centre, relative to the price it will command in Liverpool.

In the two remaining provinces, the Bahr el Ghazal and the Upper Nile Province, cotton cultivation is still largely confined to districts served by river transport. The cotton from these two provinces is carried by steamers and barges to Kosti on the railway, and thence to Makwar for ginning. At present this is possible, but any large increase in the crop will involve the installation of a ginnery or ginneries, with presses, in order to reduce the bulk of the consignments to be carried. From these districts it is possible that the seed may be worth exporting, thus adding something to the value of the crop.

AGRICULTURAL.—The agricultural problems encountered are those common to any and every scheme of agricultural development. Mainly they may be said to be those connected with the supply of good seed of a suitable variety, the improvement of methods of cultivation, and the control of insect pests and plant diseases. Even in countries where agriculture has reached a very high stage of development, work in connection with these and allied questions is continually going on. No finality can be expected, for progress, though sometimes slow, is always being made, as knowledge accumulates from the results of scientific research and practical experience. It is not claimed, therefore, that our problems, roughly outlined above, have been solved in any final sense. They are, however, being tackled, and some description of the methods of attack may be of interest.

A consideration of importance at the outset was the kind of cotton that should be grown, and the source, or sources, from which a supply of seed could be drawn. Experiments carried out at various times had shown that cottons of the staple American types could be successfully grown in many parts of these southern provinces. Conditions as regards soil, rainfall, etc., were known to vary considerably throughout the region. Sufficient experiments had not been carried out to decide definitely which variety, or varieties, were most suitable for particular districts. Before sufficiently definite results could be obtained, such experiments would require to be carried on for several seasons. In the meantime something had to be done, and as we had already growing in the Northern Sudan, under irrigation, a very useful type of American cotton, it was decided to commence with this. The cotton in question, or at least so much of it as it was proposed to take seed from, was all being grown under the supervision of the Department of Agriculture and Forests, or of the Sudan Plantations, Ltd., and ginned under their respective control. Seed of definitely known origin, and from grades of cotton decided upon, could therefore be obtained, and the continuous supply depended upon.

This policy has been justified in its results. The cotton produced has met with a favourable reception, and has been readily saleable at a premium varying from 100 to 300 points. Under any reasonable conditions this type of cotton has grown well, and has given a good yield. It is realized, however, that better results might be possible, either in the way of increased yield or better quality, by the adoption of a cotton which would be found to be even more suitable for the conditions prevailing. A carefully prepared scheme of variety tests has therefore been drawn up by the Plant Breeding Section, and is being carried out in some of the more important centres. Various types of cotton likely to be successful are being tried out against each other and against the variety in general cultivation. Any variety found to be definitely superior to the others, on a sufficient repetition of the experiments, can be selected as the type to be grown generally or in any particular district. The work of producing a bulk supply of seed of the favoured type can then be undertaken, either locally or on some of the irrigated areas in the Northern Sudan; probably the latter alternative will be adopted.

Under the conditions prevailing in the irrigated areas much better supervision of the growing crop can be exercised than is possible at present in the rain cultivation regions. Greater security of output, and a much higher yield, can also be expected under irrigation. As the various irrigation projects in the north comprise some 8,000 feddans of carefully supervised cotton cultivation, it will be understood that the production of a bulk supply of seed of any desired type could be quickly accomplished.

With regard to methods of cultivation it cannot be claimed that any great advance has been made. Throughout a considerable part of the region the absence of any domestic animals rules out any question of ploughing for the time being. Where cattle exist, experiments are being carried out with certain implements, in order to ascertain how far their use is likely to improve the output, or to extend the area which the cultivating population can cope with.

In connection with the typical heavy soils of the Sudan, it is interesting to note that the seasonal changes of climate act upon these soils in such a way as to effect a considerable natural tillage. These soils contain a very high percentage of clay. Amongst other properties clay possesses that of expanding in volume to a considerable degree when wetted, and shrinking proportionately when dried. After the rains have ceased, and the very definite dry season sets in, the clay in the soil contracts, with the result that very extensive cracking takes place. The cracks produced vary with the nature of the soil, but on typical "cotton soil" they may extend to a depth of over three feet, and individual cracks may be anything up to three inches in width at the surface. During the dry season the surface soil becomes desiccated, and is easily removed as dust by the wind. Some of this naturally finds its way down the cracks which have formed, and in places almost fills them up. When rains fall in the next season the clay expands again, the cracks are closed up, and the line of least resistance being upwards, there is a general raising of the surface level. A regular, if slow, churning movement is therefore in progress, with the result that the layer of soil affected by the cracking is constantly being moved.

The inversion and stirring is much more thorough than could be obtained by any mechanical means which it would be economical to employ, and the condition of these soils is very much better than their composition would lead one to expect. This probably explains why such good results are obtainable with what may be regarded as the most primitive tillage operations.

Nature, however, does not assist the cultivator in the same way with regard to the operations that must be carried out while the crop is growing. Weeding must be carried on, or the cotton plants become swamped in the growth of grass and other vegetation which continues throughout the duration of the rains. The primitive implements of the native cultivator are, however, capable of dealing with these, provided that the output of human energy is sufficient. In most districts some form of iron hoe is used; in some, however, a sharpened, charred stick is the only implement available.

If no great advance in the standard of cultivation can be indicated, progress can be claimed in regard to the picking and handling of the cotton. Dirty cotton is not accepted at the buying centres, but very little of it comes forward. Picking, on the whole, is very well done, and the people have been very responsive to the efforts made to induce them to keep inferior or damaged cotton separate from the good. In consequence, the grade of the cotton is good, a feature that has helped its ready sale in Liverpool.

*Insect Pests and Plant Diseases.*—Of insect pests the most important has been a red stainer bug, which at times has caused a considerable amount of damage. It has been found to be associated with certain indigenous trees, and a study of its life history and habits is being carried out by the entomological staff. A habit of congregating in masses in these trees at certain times has suggested possible means of control, the real value of which can, however, only be ascertained by further investigation. Other insects are found to attack the cotton, but so far none of these has become a serious pest. A study of all the possible insect enemies of cotton in this region is, however, being carried out, so that methods of control or prevention may be put in force whenever necessary.

Blackarm has been found to occur wherever conditions unfavourable to plant growth are encountered. Fundamental work in connection with this condition is being carried on at Khartum, and a considerable amount of information regarding the organism causing it has been accumulated, but no method of preventing or curing the disease has been devised as yet.

From what has been written it will be seen that conditions for increased cotton production have not been entirely favourable. Last season, moreover, was not at all a good one in many districts. the rainfall being deficient in some and in excess in others. Two very dry seasons in the Central and Northern Sudan had, moreover, raised the price of dura to such an extent that, in districts in the south from which it could be exported, it definitely became a cash crop, and as such more favoured by cultivators than cotton. The level of cotton prices has also been distinctly lower than when the first steps to push cotton-growing were undertaken. Considering these factors. therefore, and the other difficulties encountered, it is the more satisfactory to be able to record that distinct and steady progress has been made. The following are the production figures for the two past seasons, and the estimated figures for the present one.

| 1925–26. | 1926–27. | 1927–28. |
|---|---|---|
| 3,500 bales. | 4,800 bales. | 10,000 bales. |

It is not pretended that even the higher figure represents a notable increase to the cotton supplies of the world. It does, however, represent an important addition to the exportable products of the Sudan, and particularly of those provinces in which this cotton was grown. As already pointed out, these districts had previously produced little or nothing which could be economically exported. An export of produce, therefore, worth some £200.000 in Liverpool, and probably about half that figure to the native cultivator, marks a very definite advance. It may be taken, moreover, that it represents a real increase in production. There is no indication, for instance, that cotton has merely replaced food crops.

This is not the place to discuss the effect which such a movement will have upon the general trade of the Sudan, but it is obvious that the circulation of the extra cash realized by the sale of cotton must eventually be reflected in the increased trade of the districts themselves, and in the volume of Sudan trade generally. The balance of trade in the Sudan must be maintained largely by the export of raw materials, and if steady progress in the extension of cotton-growing in these southern provinces can be realized, the commercial position of the whole country must be improved. Such an effect must eventually react upon the trade of Great Britain and the Empire, and particularly Lancashire.

*Received November, 1927.*

A COTTON GROWING FAMILY IN THE GEZIRA

TRANSPORT OF SEED COTTON IN THE GEZIRA
(SUDAN)

The second figure by courtesy of the Editor of *Overseas*.

# *SYAGRUS RUGIFRONS*, BALY.: A CHRYSOMELID BEETLE ATTACKING COTTON PLANTS IN NATAL; AND MEASURES FOR SEASONAL CONTROL

BY

F. S. PARSONS,

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THE Division of Entomology, South Africa, reported in 1925 that a leaf and stem feeding beetle, *Syagrus rugifrons*, Baly., had caused considerable damage to cotton plants on several farms in the district of N'Gotshe, Natal, and in Zululand. It was stated in the report that the beetle had been known for several years as an occasional pest of cotton in South and East Africa.

With the expansion of cotton-growing in the N'Gotshe area increasing numbers of the beetle were observed, and damage caused by it, particularly to seedling cotton, gave rise to some apprehension. A small white grub, which attacked the roots of the cotton plants, was associated, in the minds of the growers. with the beetle. This belief was confirmed by the author, the larvæ giving rise to the beetles under field cages.

It is important to remark that the beetle concentrates, or has in the past concentrated, over patches of the crop in certain lands, and that succeeding seasons have brought a recurrence of the attack, in varying concentration, over the same patches of the same lands. This phenomenon does not appear to be correlated with a general soil type, natural flora, or local meteorological conditions, the latter being markedly variable.

Wild host plants of this insect have not been discovered here, other than *Abutilon sonneratianum*, L., which appears to serve in this respect to an unimportant degree.

The beetle infestation is not confined to the concentrated areas, but rather a few individuals may be found in almost every field. No new " Beetle Lands " have been reported or found in the older cropped fields, and new breaking has been practically negligible during the past season.

Cotton seedlings are subject to attack from October to late December. The appearance of the beetle coincides with the appearance of the seedlings, but the main infestation takes place in November. In the concentrated areas one to ten beetles may be found per seedling, feeding on the leaves and leaf stem. These may cause the death of the plant in a few days. Many patches of dead seedlings are evident, in a badly infested field, a fortnight after the commencement of the main attack. In November, 1925, an eighty-acre stand of cotton suffered a 60 per cent. death rate from beetle depredations in a fortnight; finally only a few scattered healthy-looking plants remained. Such lands resown to cotton in early December may produce a crop, given favourable rains, with little sign of the adult beetle. Many plants will be observed, however, to wilt and die, and an examination of the roots will reveal the presence of one to five (rarely more) small white grubs embedded in the tissues.

The grubs are found from five to eighteen inches below the soil surface, and are generally somewhat grouped around or along the main roots near the nodes of the upper secondary roots. The secondary roots may be attacked first, and larvæ have been found destroying the tips of them.

The larvæ eat out deep open channels, encircling the root or pursuing tortuous paths. The channels cut into the xylem and phloem strands, and where the main root is attacked the plants concerned very rapidly succumb.

Stands of seedling cotton which have been attacked by the beetle invariably suffer further notable loss of plants from the root damage of the beetle larvæ, some weeks later.

The adult beetle practically disappeared in late December, 1925 and 1926. A few stragglers were found in January, and in mid-February a mild attack of beetle was observed on some late planted cotton. Whether the latter case may have belonged to a second or other generation is not known, as studies on the cyclical behaviour of the insect are not complete.

The general course of the infestation appears to consist, then, of a massed appearance of the adult beetle on the seedling cotton from October to late December, with a maximum in November. The beetles practically disappear in December. The plants surviving the beetle attack suffer considerable losses from the root feeding of a small white grub, which is the larva of the beetle.

The damage caused by beetle feeding on large plants is slight. It has been found eating out shallow circular patches in the wall of the boll.

The full-grown beetle is about 8 to 9 millimetres in length, 4 millimetres in width, and ovoid. It is uniformly a shiny black in colour. The wing coverings (*elytra*) are hard, and bear about twenty-four orderly longitudinal lines, with continuous shallow pits between the lines, the whole providing a ridged effect. The beetle is reported to have been seen in flight, but the author has not observed this, and has been unable to induce them to fly.

Ordinarily, when dislodged from a leaf on to the ground it turns on its back, and remains motionless with legs held up. Immediately the observer moves away the beetle rapidly seeks cover beneath fallen leaves or soil lumps. During the heat of the day it commonly abandons the plants for the shade beneath large soil lumps, or takes cover in the curl of leaves which have withered as a result of its feeding damage.

The larvæ are white, cylindrical, and wormlike. They bear a light to dark brown head, and are 8 to 9 millimetres in length when full grown. The larva forms a smooth, walled earthen case, in which it metamorphoses to the beetle in the naked state. The pupation occurs in the soil at depths of 4 to 18 inches.

For a full description of the adult and its formative stages readers are referred to the Division of Entomology, Pretoria, South Africa.

Occasional beetles have been found in midwinter under clods in ploughed lands, and it is presumed they winter over as the adult.

### CONTROL MEASURES.

Preliminary experiments on the value of various insecticides in destroying the beetle were reported in 1926.* Dusting operations with Paris Green and the arsenates of lead and calcium were found to be very effective. The 1925-26 programme was interrupted by the disappearance of the beetle in December, and the tests reported concerned small plot tests conducted in February, when the infestation was comparatively mild. The trials did not permit the assessment of costs per acre.

On the appearance of the beetle on seedling cotton in the spring of 1926, commercial mixtures of the arsenates of lead and calcium were dusted over the plants in heavily infested lands on a field scale. The dusting operations were carried out by cotton farmers under the writer's supervision. The results were eminently satisfactory from the point of view of mortality. One application of calcium arsenate over a very heavily infested block of 20 acres caused an estimated kill of 90 per cent. In this instance the beetles, if allowed to proceed unchecked, would have destroyed the stand.

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* Reports from Experimental Stations E.C.G.C., 1925-1926, F. S. Parsons, Candover Experiment Station.

The arsenates of lead and calcium and Paris Green were equally effective. Of the three insecticides, calcium arsenate is the cheapest in South Africa. The following costs of application are based on the use of this poison.

The equipment at disposal consisted of two animal-drawn dusting machines and three types of hand blowers. The animal-drawn apparatus was not satisfactory with oxen, but might be used to advantage with steady mules, if the planter has sown straight lines; otherwise there is great waste of insecticide, and too many plants do not get dusted. Such machines would require considerable modification in order to perform efficiently over seedling cotton. Of the hand dusters, a knapsack type was found most satisfactory.

The commercial calcium arsenate mixture employed consisted of calcium arsenate of 40 per cent. $As_2O_5$ and a carrier. Five pounds of this mixture per acre were sufficient for an adequate distribution.

Tests showed that one native labourer could thoroughly dust 3 acres in a nine-hour working day, using a knapsack duster. The prevailing daily wage and food cost for a full-grown native is 1s. 10d. The acre cost for one application of calcium arsenate would therefore be:

| | |
|---|---|
| Labour .. .. .. .. | 7½d. |
| Insecticide (5 lbs. per acre) .. .. | 3s. 10½d. |
| | 4s. 6d. |

The cost of insecticide includes railage and other transport charges. The outlay on equipment and interest and depreciation thereon would require to be distributed. The cost of applying the insecticide is an important consideration at 4s. 6d., when a crop may otherwise be brought to reaping for a sum in the immediate neighbourhood of 30s. It is not improbable that the introduction of crop rotation will reduce the pest. In any event, it would seem advisable to throw the "Beetle Lands" out of cotton cultivation for a period of perhaps three years. A careful watch on minor infestations would be profitable, as these could be dusted piecemeal, and the spread of the beetle checked.

*Received August*, 1927.

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# THE ROUND BALE

BY

ROGER THOMAS, B.Sc.
*Formerly Inspector-General of Agriculture in Iraq.*

During a recent tour of inquiry through the Cotton Belt of the U.S.A., the writer was impressed with the high costs of handling the American cotton crop and with the extraordinary amount of wastage associated with the marketing of cotton between the field and the factory. Both the wastage and the high costs of handling are in large part due to antiquated practices which have grown with the industry. The organization involved is one of vast dimensions, necessitating, even before shipment, a bevy of middlemen amongst whom are included the country buyer, the factor, the dealer, the broker, the merchant, and the shipper, each of whom expects his legitimate profits on every consignment handled.

Marketing, from the standpoint of the owner, may be considered as the means whereby a physical commodity is converted into purchasing power of value. The efficient conversion of raw cotton into purchasing power, involving ultimately the delivery from the field to the spinning mill, necessitates the performance of several essential services, amongst which are included preparing, standardizing and grading, baling, assembling, distributing, warehousing, inspection and regulatory work, financing, furnishing information, and risk-taking. An efficient marketing service should require in payment for its services only a small proportion of the value represented by the commodity handled.

The system of marketing cotton in vogue in America, though admittedly effective and reasonably expeditious in operation, reeks of waste, and is overburdened with overhead charges, the incidence of which ultimately falls on the cotton-grower. To quote an eminent American economist, Edward Atkinson: " The American square bale is our most wasteful, most barbarous article of commerce."

With the exception of the recent relatively minor improvements in ginning machinery, the very recent developments in picking cotton by machinery, and the relatively slow but steady acceptance of the round bale by a section of the spinning trade, mainly on the Continent, there have been no outstanding improvements in the handling of the cotton crop since Eli Whitney invented the cotton gin in 1793.

Within recent years there has been a general trend in industries to reorganize by concentration through fewer hands. Efficiency, elimination of waste, reduced overhead charges, concentrated technical skill, and a closer association between producer and consumer, are factors which contribute to a much greater degree than hitherto to the success of commercial enterprises. There is still room enough for the extended application of these factors, and more particularly so in some sections of the cotton trade. The establishment of official cotton standards by the Government of the U.S. for the classification of American cotton laid the foundation for many improvements in cotton marketing methods. These standards have helped in particular to clear the ground for developing and improving the *service* features of the trade.

To change an established custom requires time for adjustment to the new conditions. There are indications that many of the older established practices associated with the handling of cotton are latterly evolving from the chrysalis stage. New forces are now operating, and in this connection one of the chief contributing factors is the co-operative movement amongst growers, which serves to establish closer connection with the spinner, thereby ensuring a greater degree of continuity of interest in the raw product between the field and the factory. But much is also being done through the personal initiative and enterprise of those merchants associated with the trade who seek to adjust their methods to changing conditions. Outstanding in this latter respect is the establishment of the round bale; and it is this avenue which the present article is designed to indicate as one which appears to hold out much promise for the effective curtailment of handling costs, and for the elimination of part of the waste associated with the marketing of the cotton crop.

Before proceeding to a consideration of the round bale it is as well, in order to visualize the problem in better perspective, to recount briefly the customary manner in which the American bale is handled between the gin and the port of shipment.

The American crop is ginned in the vicinity of the cotton fields almost immediately after enough cotton has been picked to form a bale. Some idea of the damage done to cotton at the gin, and of the wastage which must result therefrom, may be gathered from the fact that of the 248 ginneries studied by the Oklahoma Cotton Growers' Co-operative Association 190 were damaging the cotton for one or more causes attributable to defective maintenance or manipulation of the machinery.

The raw cotton is pressed at the ginnery into what is commonly known as the "square" or "flat" bale. The baling press is an essential part of the equipment of every ginnery, but owing to the heavy cost of high density hydraulic presses most ginneries are fitted with the less costly screw press operated by steam. In steam presses there is a tendency to condensation in the cylinders, and very often the water escapes through faulty packing on to the cotton in the press box. This is the cause of the majority of the "water packed" bales with "felted" spots, which are responsible for a considerable amount of wastage and difficulty in the process of spinning. The gin-pressed or flat bale may be further compressed once, and in most cases twice, before it is shipped. At each process its dimensions are reduced, whereas its original square shape is retained.

In the process of gin-pressing, two sides of the bale are wrapped in coarse open-weave jute bagging or burlap made of all the different grades and types, and with six ties or hoops of iron. The edges of the bagging are not sewn together, so that two sides of the bale are only partly covered, and its ends are also frequently left uncovered. The two ends of the six individual ties are clamped together before the press is released. The density of the gin-pressed bale averages 12½ lbs. per cubic foot, and the weight averages 500 lbs. gross, with extreme fluctuations of 350 and 750 lbs. and normal fluctuations ranging from 450 to 550 lbs.

On being gin-pressed the square bale is sampled in two places by cutting the bagging between adjacent hoops with a knife along three sides of a rectangle. From 1 to 3 lbs. of cotton are removed by country buyers at the time of sampling. The bale may then be taken direct to the nearest compress warehouse by order of the owner, or it may be country compressed at the convenience of the railway authorities so as to economize in rolling stock; but more frequently it is dumped in open storage yards, to be removed when rail transport becomes available. It is at this stage that cotton bales suffer most from "country damage," which results mainly from exposure to rain and to the absorption of moisture from the ground. Generally there is also an appreciable loss at the country storage yards on account of pilfering, estimated roughly at an average of 2 lbs. per bale.

On reaching the country compress, where the cotton is warehoused under cover, the ties are removed; the bale is compressed by hydraulic pressure to a density of 22 to 25 lbs.; patches of burlap are added to cover the holes previously made at the time of sampling; normally seven ties, and frequently eight, are fitted instead of the original six; and if the cotton is offered for sale while at the country compress it is again sampled in the same manner. In due course it is consigned either direct to American mills or to the port of shipment, to be deposited in the port compress warehouse, where it is finally compressed for export shipment to a density of 33 to 35 lbs. with eight to ten ties; more patches are added in the latter case; generally two more samples are taken; "country damaged" cotton is removed from the bale with steel combs; and extra charges are made for storage, weighing, applying patches, re-tagging, sampling, ranging, marking, loading, etc. Further samples are taken each time the bale changes hands. After being recompressed to high density the bale may then be shipped direct or, as frequently happens, it may be shipped to New York, where it is delivered on contract for reshipment to its destination. By direct shipment to Great Britain a saving of about $4 per bale is effected.

Of the 500 lbs. gross weight of the *standard compress* bale for export consumption indorsed for American cotton by English spinners, 4 per cent., or 20 lbs., is tare which is comprised of bagging and ties. Customarily a deduction approximating to the actual tare is assessed in Europe against the American *high density* square bale; this deduction is 6 per cent., or 30 lbs., for a bale of 500 lbs. When sold for domestic consumption American cotton is tared at 22-24 lbs. per *standard* bale, country compressed, having a density of 22-25 lbs.

In so far as rail freight, ocean freight, and insurance are concerned, tare has to bear the same *pro rata* charges as raw cotton. The gross rail and ocean freight charges for transporting a bale of cotton from the field to Europe amount on an average to about $8.50. Of this, 6 per cent., equivalent to about 50 cents per bale, is due to tare. With an American crop of 18,000,000 bales it is estimated that the initial cost of bagging and ties, together with the *pro rata* charges borne by these in transit (part domestic and part export), averages about $1.75 per bale, or a total of about $31,500,000 for the 1926 crop alone.

Many cotton merchants aver that the present trade rules concerning *gross* tare are responsible for a great deal of the economic waste from which the American crop suffers. The Ransdell Bill, recently introduced into Congress, which proposes to delegate powers to the Secretary of Agriculture to fix the standard covering of cotton *at the gin*, may perhaps help to remove some of the abuses associated with tare. But the present rules and conditions regarding tare will need a considerable amount of revision and concerted international action before any radical improvement can be expected on this score. American rules allow a certain amount of tare; foreign rules allow a different amount; and both are in percentages of the gross weight of the individual bale. Besides, owing to local custom 100 Texas bales in a consignment may average 550 lbs., whereas the same number of Atlantics may average only 460 lbs. Merchants try to adjust weights at the compress when patching; but with varying weights of cotton in the bales and with irregular weights of initial tare and of patches previously added, correct taring at the port of shipment is practically impossible. The merchants' difficulties are accentuated by the fact that they do not know before compressing whether the bale will be sold for domestic consumption or for foreign shipment; and, therefore, they cannot foretell the precise weight of patches which they may be allowed to add with impunity. In addition the foreign markets, when determining the actual tare on any bale, allow separately for bagging and for ties. This results in the merchants frequently having to pay tare claims for excess weight of bagging, although the weight of the ties may be below the regulation allowance, and *vice versa*. Merchants also have to pay the costs of taring and controllers' supervision fees on practically 10 per cent. of all export shipments. Many authorities are of the opinion that if merchants, shippers, and spinners would agree to accept a *nett weight* basis for delivery, then appreciable savings could be effected to the advantage of all concerned.

This rough and brief survey of some of the features concerned with the handling of the American crop suffices to show that big money is involved, that the trade itself is in large part dissatisfied with many of the prevailing practices, and that there is room for eliminating much of the economic waste associated with this branch of the industry.

The round bale, as originally placed on the market to an appreciable extent about twenty-five or thirty years ago, had certain undesirable features which eventually caused its abandonment. It had a hard core, resulting from it being wound on a spherical steel rod which was forcibly removed on completion of the baling process; and the cotton at the centre of the bale was damaged, due to excessive pressure and coincident friction at the centre. A powerful corporation was formed to exploit this novel method of baling, which, it is reported, ultimately resulted in a few hundred thousand round bales being handled. Unfortunately the operating company did not succeed in eliminating the defects of the original round bale. After the project had attained to fairly large dimensions the supply exceeded the demand; the foundation of the business was insecure; and the organization as a whole proved inadequate to cope with the multifarious problems which must of necessity arise in instituting on a large commercial scale such a radical change in marketing methods. The initial effort to establish the round bale proved a disastrous failure, and a great deal of capital was lost in the enterprise.

During the past fifteen years another attempt has been made to establish the round bale by a company of buyers and shippers who before the Great War were practically unknown to the trade, whereas today they are probably the leading cotton merchants of the world. They have succeeded in eliminating the objectionable features associated with the original round bale, and have latterly built up a substantial business in this branch of the industry with a round bale which bears the trade name "Acco."

Some idea of the steady progress which has been made in establishing the Acco round bale may be gathered from the following data:

STATEMENT SHOWING THE PROGRESSIVE INCREASE IN THE DEVELOPMENT OF THE ROUND BALE.

| *Season.* | *Total American Crop in Running Bales (counting Round Bales as Half-Bales).* | *Round Bales (of 250 Lbs.) produced in U.S.A.* | | | |
|---|---|---|---|---|---|
| | | *Total Round Bales.* | *Acco Round Bales.* | *Acco Bales as Percentage of Total Round Bales.* | *Round Bales (counted as Half-Bales) as Percentage of Total American Crop.* |
| | | | | Per Cent | Per Cent |
| 1916–17 | 12,738,000 | 192,339 | 134,208 | 70 | 0·76 |
| 1917–18 | 11,865,000 | 189,076 | 161,536 | 86 | 0·80 |
| 1918–19 | 11,360,000 | 154,204 | 126,479 | 82 | 0·68 |
| 1919–20 | 12,553,000 | 114,305 | 99,356 | 87 | 0·46 |
| 1920–21 | 11,377,000 | 206,534 | 180,729 | 87 | 0·91 |
| 1921–22 | 11,653,000 | 123,791 | 119,503 | 96 | 0·53 |
| 1922–23 | 11,283,000 | 172,182 | 160,541 | 93 | 0·77 |
| 1923–24 | 11,290,000 | 242,307 | 224,862 | 93 | 1·08 |
| 1924–25 | 13,639,000 | 314,325 | 305,514 | 94 | 1·18 |
| 1925–26 | 16,122,000 | 351,121 | 344,497 | 98 | 1·09 |
| 1926–27 | 17,687,000 | 663,786 | 647,805 | 98 | 1·88 |
| 1927–28 | 12,500,000* | 750,000* | — | — | 3·00* |

It is anticipated that the portion of the 1927 crop which will be marketed in round bales will approximate to 750,000 bales of 250 lbs. These are significant figures, and are indicative of the recent trend of events. Practically the whole of the round bale business is controlled by one company who hold the patent rights in the Acco press. There were about 200 of these presses in operation in the

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* Estimated.

U.S.A. in 1926; and it is understood that more ginneries will be equipped with this type of press preparatory for the 1927 crop.

Space limitation does not permit of the technicalities and the detailed mechanism of the Acco press being described here. It will perhaps suffice for the present purposes to consider only the process of manufacture of the Acco round bale.

Fig. I. illustrates the general design of the Acco press. It can be fitted to any modern type of ginning plant. Cotton is delivered from the gins to the condenser which forms the upper part of the structure. In the condenser the lint is formed into a bat 4 inches thick and 3 feet wide. This bat is fed automatically into the top of the baling mechanism, which appears in Fig. I. lying horizontally under the condenser at ground-level. This consists of nine corrugated steel rollers which rotate on their own axes at a uniformly slow speed, and are together enclosed in a steel drum (Fig. II.). The rollers are so arranged as to leave a central cavity 3 feet long and 24 inches in diameter to accommodate the finished bale. The action of the rollers is such that they exert a slight pull on the fibres as the bat enters the press. This action tends to draw the individual fibres and to lay them parallel. It appears that this feature of the Acco bale is favourably commented upon by spinners. By a special process a large percentage of the short wasty fibres are removed from the cotton while being pressed; this cleaning process is additional to the treatment which cotton receives when pressed in square bales.

As more and more cotton is fed into the cavity in the form of a bat, the pressure on the rollers is allowed to increase until an indicator shows that about 250 lbs. have been accommodated. Burlap (bagging) of high grade, and of sufficient length to cover completely the length of the bale, is then fed into the press. The bale is released by means of a lever, and it rolls on to the floor, where the edges of the bagging are sewn together by hand, and two end patches of bagging are at the same time affixed, thereby *completely* covering the bale. No hoops are added; and the bale, being classed as high density, is ready for shipment without further treatment. The density averages 35 lbs. per cubic foot, and may vary from 32 to 37 lbs. The tare is 2½ lbs. (or 1 per cent. as compared with 6 per cent. for high density export bales). Considerable care is taken to prevent "country damage," and in consequence all Acco bales are either immediately put on rail or stored in weatherproof warehouses to await rail transport. No hooks may be used to hoist or handle the bale; and it may only be sampled at the ends. The bagging on the Acco bale is never cut when sampling, which is done with a special auger.

Round bales of 250 lbs. can be conveniently handled without the use of a hoist by one man, and stacked in two tiers by two men, or by three men to a height of 8 or 9 feet when arranged on their sides. The bale can be opened by cutting the stitches in the bagging and removing the latter. The bat may then be unwound in a continuous layer, ready to be thrown into the bale breaker at the mill; or, if preferred, the bale may be broken open by tearing it down to the core by hand.

The Acco bale is only pressed once in contrast with the three times to which the square bale is normally subjected when exported, and it is only sampled twice—namely, one sample of ½ lb. at the port of shipment, and another of the same weight at the port of disembarkation: whereas from four to eight samples of about 1 to 2 lbs. each are taken from the square bale, depending on the number of ownership changes.

Comparative Data relating to the Square Bale and the Acco Round Bale.

| *Method of Baling.* | *Approximate Dimensions.* | *Average Gross Weight.* | *Density per Cubic Foot.* | *Ties.* | *Average Weight, Bagging and Ties.* | *Weight Samples per 500 Lbs.* | *Cost, Bagging and Ties.* |
|---|---|---|---|---|---|---|---|
| | Inches. | Lbs. | Lbs. | Nos. | Lbs. | Lbs. | $ |
| SQUARE BALE.<br>*First Process:*<br>Gin-pressed bale uncompressed | 54 × 27 × 45 | 500 | 12–15 | 6 | 21 | 9 lbs. generally allowed by the trade as conservative. | 1·80 |
| *Second Process:*<br>Standard compress bale | 56 × 28 × 22 | 500 | 22–28 | 7–8 | 22–24 | | Extras for "patches" and additional ties. |
| *Third Process:*<br>Port compress, high density bale | 59 × 24 × 19 | 500 | 28–40 | 8–10 | 25–30 | | |
| ROUND BALE | 35 × 22diam. | 250 | 32–37 | *Nil.* | 2½ | 2 | 0·50 |

In view of the theoretical waste in floor space when using round bales, it is of interest to compare the actual measurements of floor space occupied by the round bale and by the high-density square bale respectively. Measurements made on several lots stored at a compress warehouse showed that the average floor space required for one square bale was 4·45 square feet, and for two round bales (when these were stacked end on end) was 4·42 square feet. The difference, though slightly in favour of the round bale, is really negligible, but at the same time it is significant, and is to be attributed to the irregular shape of the so-called " square " bale.'

Great care is taken by the proprietors of the Acco press in the selection of suitable ginnery owners, efficient ginneries, and desirable localities for the installation of their presses. Strict supervision is maintained, and an exceptionally high standard of service is observed. The result is a high degree of uniformity in the marketed product, which is naturally appreciated by that section of the trade which is accustoming itself to the use of the round bale. All the bales turned out by Acco presses are bought, sold, and handled throughout by the one operating company. Nearly all Acco presses are confined to that portion of the Cotton Belt which lies west of the Mississippi Delta, mainly in Texas and Oklahoma; and it appears that the company will only extend its activities to other sections of the Cotton Belt in consonance with the increased demand for the round bale by spinners, and with the rate at which it can multiply its efficient organization, at present centralized in such a manner that all Acco bales can be handled at one port of shipment.

A ginnery equipped with an Acco press requires a power plant with about 35 h.p., additional to that required to operate the usual types of steam presses installed in ginneries. No deep foundations are required, and the press can be installed by qualified mechanics ready for operating within about four days of delivery. The capacity of the Acco press is limited only by that of the ginning installation.

Only three Acco presses have been supplied outside the U.S.A. Of these, the two sent to Russian Turkestan are believed to be functioning, whereas the one supplied to Indo-China is reported to be no longer in operation.

It appears that a different type of round bale press, operated by a separate company and capable of producing a 500-lb. bale, is now being exploited in the stapled section of the Mississippi Delta.

The round bale has been subjected to a certain amount of criticism which the writer has been at some pains to investigate. Practically the whole of the round bale supply of 663,786 bales from the 1926 crop was of a staple length around 1 inch. The proportion of the round-baled crop of 1¼ inch and over is negligible. It is contended by some merchants who are interested in the stapled section of the trade that round baling by the present method is not equally well suited to stapled cotton because of the damage resulting from the drawing of the long fibres by the rollers. No proof of this contention, supported by experimental data, could be found; and in the course of the inquiries it transpired that the view is in part dictated by hostility from long-established interests in the square bale, and partly to the incidental but economic concentration of the round bale business in one section of the Cotton Belt where little stapled cotton of $1\frac{1}{8}$ inch and over is grown. Besides, merchants and spinners who have had no experience with the round bale as now marketed are disposed to be prejudiced against it on account of the defects of the original round bale with its damaged core and the consequent failure of the initial operating company.

Most of the round-baled cotton is consumed on the Continent, a relatively small portion in Great Britain, and practically none in the U.S.A. There appears to be greater prejudice in England than on the Continent against the round bale. It was not ascertained why practically none of the round bales were consumed in the States, but it is obvious that greater savings are effected with the round bale when used for export than for domestic consumption.

The following data, which are believed to be conservative, serve to indicate the considerable savings which could be effected in handling cotton after the manner in which Acco bales are handled by direct shipment to the spinner. For the purposes of these estimates the tare on the square bale is taken to be 6 per cent., or 30 lbs., and on the round bale 1 per cent., or 5 lbs., on two bales of 250 lbs. each.

ESTIMATED AVERAGE SAVINGS WHICH COULD BE EFFECTED BY SUPPLYING THE ROUND BALE BY DIRECT SHIPMENT TO THE SPINNER IN EUROPE.

| | *Dollars per Bale of 500 Lbs.* |
|---|---|
| Rail freight: ginnery to port, 25 lbs. difference in tare at 50 cents per 100 lbs. .. .. .. .. .. .. | 0.12 |
| Rail freight allowance on high-density bales from ginnery to port .. .. .. .. .. .. .. .. | 0.45 |
| Cost of bagging and ties: square bale, $1.80; round bale, $0.50 .. | 1.30 |
| Country compressing .. .. .. .. .. .. | 0.60 |
| Port compressing (high density) .. .. .. .. .. | 0.75 |
| Patches .. .. .. .. .. .. .. .. | 0.66 |
| Country damage, etc., at 4 lbs. per bale at 15 cents. per lb. .. | 0.60 |
| Difference in marine insurance: square bale, $1\frac{9}{16}$ cents per cent.; round bale, 1 cent per cent. .. .. .. .. | 0.34 |
| Ocean freight: New Orleans to United Kingdom on 25 lbs. difference in tare at 75 cents per 100 lbs. .. .. .. | 0.19 |
| Additional compress charges on square bale: storage, extra ties, re-sampling, picking, applying patches, conditioning, marking, tagging, etc. .. .. .. .. .. .. | 2.00 |
| Total savings per bale of 500 lbs. .. .. | $7.01 |

Additional savings, which are difficult to estimate, would include losses on the "city crop," interest on delayed shipments, considerable economy in rolling stock, etc.

In the case of cotton consumed in the country where it is produced the savings would of course be appreciably less than indicated in the above estimates for export shipment. Taking the world's annual cotton crop as 30,000,000 bales, of which, say, one-half is consumed in the country of production and the other half exported, it is believed that $5 per bale would represent a fair estimate of the gross savings which could be realized by adopting the round bale and establishing direct connection with spinners. This is equivalent to $150,000,000 a year, or about one-sixth of the gross costs of marketing and handling a 30,000,000 bale crop.

The estimates now furnished are recorded mainly as an indication of the enormous sums involved. It is fully realized that the shipment of the *whole* of the world's cotton crop direct from the field to the factory, whether in round bales or otherwise, by cotton merchants. without making use of other intermediaries, is not a practical proposition. The round bale is not tenderable against futures contracts; and in this connection it is of interest to note that the whole of the Acco bale industry has been built on direct shipment to spinners. Until, therefore, the Cotton Trade Regulations are amended so as to permit the round bale to be tendered against futures contracts, there would appear to be but little opportunity for the successful establishment of the round bale method of marketing cotton in any country, except in cases where the owners of round bale presses can arrange to dispose of the whole of their stocks by direct shipment to spinners.

Much patient and courageous enterprise has been necessary to establish the round bale business even to its present dimensions. And if the enthusiasm of all who are directly concerned with the round bale at the production end is any indication of its true merits, then we can confidently look forward to the rapid expansion of this commercial effort, which has already succeeded in breaking away from long-established customs in virtue of economies effected.

This conspectus of the round bale problem has been designed more with the view to emphasize the need for greater economy in handling the square bale than for the widespread adoption of the round bale. There are strong reasons for believing that competition arising out of the steady expansion of the round bale business will of itself stimulate the adoption of more economic methods with the square bale. Vested interests in the latter are so powerful, the lack of continuity of interest in the marketed product is so manifest, and the profits accruing in most years to the majority of middlemen associated with the prevailing method of marketing the American crop are so well assured, that it is not surprising to find neither the desire nor the incentive to change existing methods by those whose source of income so largely depends on the perpetuation of the present system. But there is already observable a little nervousness amongst some of the older established houses on account of the development of the round bale business and of co-operative marketing; and it is very probable that material improvements will not be effected in the handling of the square bale until reconstruction is forced on this section of the cotton industry by those extraneous competitive agencies now operating on more economic principles.

*Received August,* 1927.

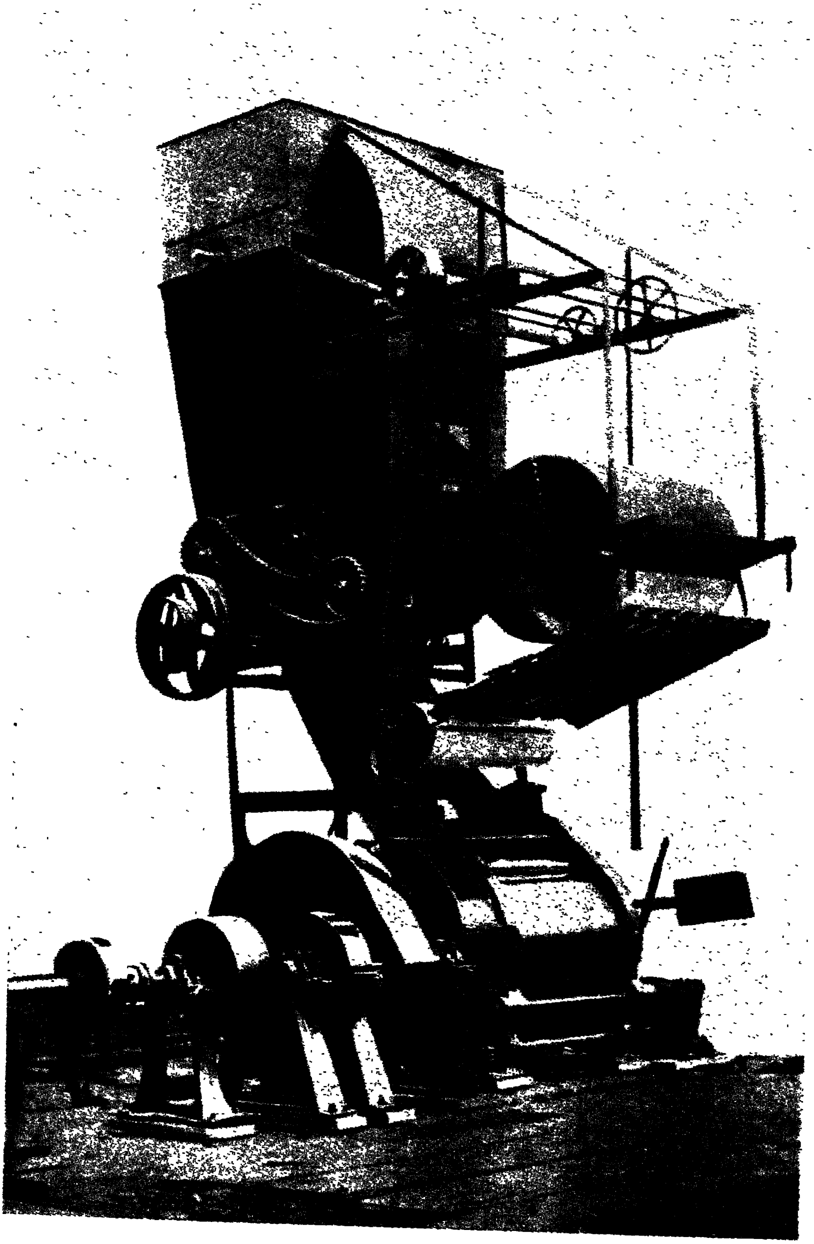

FIG. I.—THE ACCO ROUND BALE PRESS

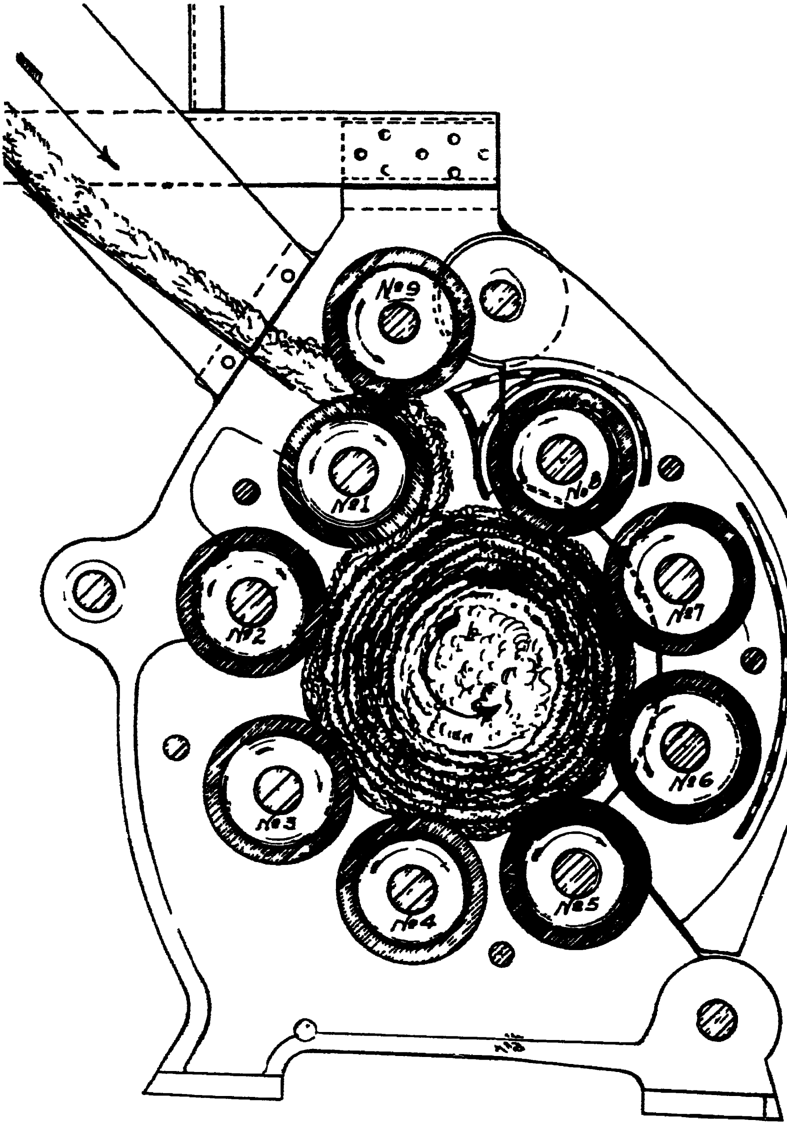

Fig. II.—A Side Drawing of Round Bale Press Interior

Top arrow shows cotton bat entering press between rollers Nos. 1 and 9. In the centre is seen the bale—built up in a continuous roll around its soft centre.

FIG. III —METHOD OF OPENING ROUND BALE FROM THE SIDE

FIG IV —ROUND BALE AFTER HAVING BEEN SPLIT DOWN THE SIDE TO THE CENTRE

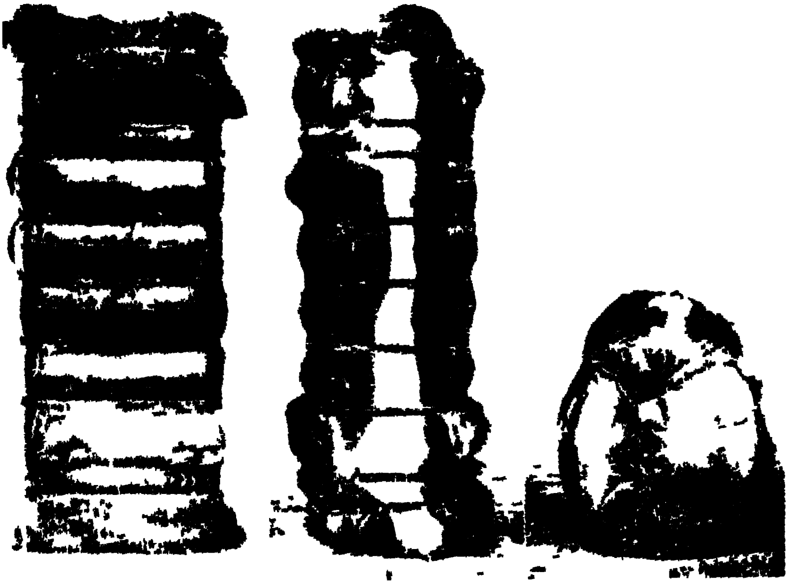

Fig V.—High-Density Port Compress Bale Top, Side and End Views

Fig. VI —Round Bale Side and End Views

# SOME CONDITIONS INFLUENCING THE DEVELOPMENT OF BACTERIAL DISEASE OF COTTON (*Bacterium malvacearum*)

BY

W. P. K. FINDLAY, B.Sc., A.R.C.S.

THE following is a summary of some work carried out in an attempt to determine some of the conditions influencing the development and spread of the bacterial disease of cotton caused by *Bacterium malvacearum.** This disease is well known in all important cotton-growing countries, and causes greater or less damage according to the form in which it appears. In the U.S.A., where the leaf is usually attacked, giving rise to "Angular Leaf Spot," the damage is not often great; while in the Sudan the disease is a serious one, as the stems and branches are frequently killed by the so-called "Black Arm Disease." The importance of Bacterial Boll Rot has never been accurately determined, though it undoubtedly causes considerable losses under certain conditions. The identity of the organism causing these different stages was not established for some time, but has now been proved conclusively by many workers by means of inoculation experiments. The symptoms and appearances of the disease have been well described by E. F. Smith in his book "Bacterial Diseases of Plants, 1920,"[11] where also a complete account of the cultural and other characteristics of the bacterium are given. Thus the physiology of the bacterium has been well worked out, but we know very little as to the condition in which the cotton plant is most susceptible to attack, and it was with a view to determining this that the present work was undertaken.

The bacterium was isolated by the usual methods, and a number of preliminary experiments were made to test out the cultures and to gain familiarity with the disease. Typical Angular Leaf Spot was produced, which progressed as has been described by Smith.[11] Similarly boll rots were induced by inoculations of both flowers and young bolls. The Black Arm stage, however, scarcely ever developed except where the stem had been punctured. Field conditions in Trinidad do not seem generally to favour these bacterial diseases, which, although present in the small plantations on the College Estate, etc., seldom appear to cause any real damage there.

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* More correctly *Pseudomonas malvacearum* (E. F. Smith).

Varieties Susceptible.—A number of varieties of cotton were sown in the field plot, and inoculated by spraying on a suspension of bacteria in the evening. Considerable differences in susceptibility were found. Egyptian (Sakel) and Sea Island were found to be freely susceptible, and the local Trinidad Red Kidney cotton also showed Angular Leaf Spot. Upland varieties scarcely developed the disease at all under the conditions of these experiments, and Asiatic varieties (Million Dollar and *Gossypium cernuum*) were completely resistant.

In the pot experiments Pima proved rather more susceptible than Sea Island, especially as regards the lesions on the stem, which extended further than on the Sea Island plants.

Flower and Boll Inoculations.—Numerous inoculations of flowers and bolls in various stages of growth were made by pouring a little of the bacterial suspension down the corolla tube or on to the boll. Infection of the flowers of Sea Island and Egyptian cotton was in every case followed by large bacterial lesions on the young bolls. Fine tendrils of a yellow material that soon hardened were exuded from around these areas; they were examined and found to consist of bacteria only. The bolls soon became infected with secondary parasites, which, gaining entrance through the lesions, rotted the contents of the boll. Chief among these was a dark Aspergillus (*A. niger* ?); this fungus has been reported by Summers[13] as causing a boll rot of cotton in a greenhouse at Didsbury. Under normal conditions it is unable to gain entrance to a boll, but, like many weak parasites, after entry through a wound or dead area seems able to bring about a rot. Edgerton[5] found that species of *Fusarium*, *Diplodia*, and *Glomerella* all gained entry after the way had been paved by *B. malvacearum*. It is this fact that makes the bacterial attack on the boll of great importance; not a fibre of good cotton was obtained from bolls which had been inoculated in an early stage or in the flower, and most of the seeds were rotten and non-viable.

On plants that had already set a considerable number of bolls, infection of the flower usually caused the young boll to be shed within a few days. G. H. Jones[9] in Nigeria gives very definite figures for boll shedding due to bacterial attack, and states that it may amount to 12 per cent. for American cotton, and 18·7 per cent. or the native varieties.

Natural infection of the flower has been stated by Edgerton[5] to be due to insects, and it is difficult to imagine how a drop of infected water or particles of infected material could otherwise penetrate down the long corolla of some varieties during the short time that it is open·

TRANSMISSION OF THE DISEASE.—The whole question of the natural transmission and spread of this disease has been a matter of considerable controversy. It is generally agreed that infection is carried by the seed; by many it was held that this is external and *on* the seed coat, a supposition that ill agreed with the known characteristics of the bacterium, which is extremely sensitive to light and desiccation. Many American workers claim to have completely controlled the primary infection by sterilizing the outside of the seed, and G. H. Jones[9] reports that disinfection of the seed that was sown on a $\frac{1}{10}$-acre plot at Ibadan (Nigeria) resulted in a crop completely free of disease. Barre[3] recommends the use of dilute mercuric chloride after delinting; this would seem rather superfluous. Izal too has been recommended for this purpose. But Archibald[1] in a recent paper proves quite conclusively that the bacteria may exist *within* the tissues of the seed, and so any external application of poisons cannot be effective. However, he has also shown that treatment of cotton seed with sulphuric acid leads to quicker and better germination,[2] and so the plant has a better start, and perhaps, therefore, can grow away from infection. This, together with the fact that those infected seeds with a defective seed coat may be killed entirely by acid treatment. may explain the results obtained by the American workers. We cannot look upon the sulphuric acid treatment as a perfect means of control, though it may be of use for other reasons. Recently it has been shown that this treatment may be carried out much more economically by using diluted acid in the minimum quantity, and that liming the seed can safely replace washing after delinting.[12]

EXPERIMENTS.—1. Seeds from bolls which had been inoculated in flower or as a young boll were sown in rows in boxes of sifted soil at the end of March about six weeks after they had been gathered. A large proportion of the seeds (approximately half) failed to germinate. The seedlings were examined on May 5, when the third leaf was developing; out of fifty-one seedlings two showed definite bacterial lesions in the cotyledons. The small percentage of attacked plants is probably explained by the fact that very few viable seeds were obtained from any boll that had been inoculated while in flower.

2. Attempts were made to grow diseased seedlings from healthy seed by external inoculations.

Seeds of Sea Island cotton that had been sterilized in sulphuric acid and washed were sown in the pots of soil that had contained the diseased plants, and where a number of infected leaves were buried. In two of the pots the seeds received in addition a direct watering with a strong suspension of bacteria. The plants were grown on for several weeks after reaching the surface, but in no case was any bacterial disease observed.

External infection of the seed appears to be of no importance, and transmission of the disease through infected soil has never been observed. This latter is a fact of considerable economic importance, and obviates the necessity of growing another crop in the following year on land where cotton was badly affected in any one season with bacterial disease.

EXPERIMENTS AFFECTING THE METABOLIC CONDITION OF THE PLANT.—Recent work has shown that the metabolic condition—in other words the carbohydrate-nitrogen ratio—of a plant is all-important in connection with its susceptibility to attack by parasites, and so an effort was made to determine in what phase of its life the cotton plant is most susceptible to bacterial attack, and a number of experiments were performed with this end in view.

FIELD EXPERIMENTS ON RINGING.—It is well known that a plant may be brought into the carbohydrate (fruiting) phase by partial or complete ringing of the stem, thus preventing the transfer of the materials of assimilation from the shoot and at the same time reducing the water supply.

Two similar plants of Sakellarides cotton growing close together were selected, which had been planted on November 27, and in one of them the stem was almost completely ringed down to the wood, a few inches above ground level, on February 3. Both plants were sprayed with a suspension of bacteria (8 tubes in 2 litres) from an Abol syringe on February 17 and regularly examined after this, and on March 17 the total amount of lesions on each was counted.

The ringed plant showed—

1 leaf attacked,
1 boll attacked,
1 doubtful lesion on stem.

The control was found to have—

15 leaves attacked,
3 bracts attacked.

The ringed plant thus seemed definitely to be less susceptible.

This experiment was repeated; two similar plants of Sakellarides cotton growing in the same hole, that had been sown on December 12, were chosen. One of these was almost completely ringed on March 23, and both were sprayed with bacteria on April 2. On May 4 they were carefully examined—the ringed plant was then found to have 9 leaves and 2 bracts affected. The normal control plant had 18 leaves (some very badly) and 7 bracts attacked. This result agreed well with the one obtained previously.

A similar experiment was performed with a variety of Upland cotton (Webber), but without result. Under Trinidad conditions Upland cottons do not appear susceptible to Angular Leaf Spot, and none of the varieties experimented with ever took the disease. An attempt was made to render them less resistant by keeping them in the vegetative phase through continued removing of the flowers and squares, but without success.

GRAFTING EXPERIMENTS.—The growing of a cotton upon stocks of greater or less vigour appeared a means of controlling in some degree the physiology of the plants, and numerous grafts of one variety on another were made, using the bottle method recommended by Harland.[7] Owing possibly to the strong winds prevailing at the time, which dashed the plants about and broke the newly forming connections between stock and scion, comparatively few of the grafts were successful. Sea Island plants, however, were grown successfully on Million Dollar (a Chinese variety) and on Half and Half (Upland); these were sprayed with a suspension of bacteria on April 2, and by May 4 had developed typical Angular Leaf Spot.

The development of the grafts was not sufficiently regular, and the distances between them and the control plants were too great to justify any comparisons being made; however, growing one susceptible variety on an immune stock does not seem to increase the resistance of scion—a result that was to be expected.

It is suggested that this experiment is worth carrying out on an increased scale, the grafting to be done on stocks of uniform size and age, in pots, which would afterwards be planted out. Especially interesting would be the comparison of resistance of the same plant grown on a dwarf early maturing stock and on a slowly maturing perennial type. Sea Island cotton was successfully budded on to a perennial cotton (Jamaica Long Staple), and this in some cases might be a more convenient method than grafting.

EXPERIMENTS IN THE GLASSHOUSE—*Ringing Experiments.*—Similar ringing experiments to those in the field were repeated in the greenhouse.

Sea Island cotton seed was sown in cans on March 8, and the seedlings were later thinned out to two per pot. On May 6 three cans each containing two similar plants were chosen, and one of the plants in each pot was almost completely ringed at a few inches above ground level. On May 17 all the plants were sprayed with a suspension of bacteria (15 tubes in 2 litres) from an Abol syringe, and the plants were carefully examined on June 17 and the number of diseased leaves on each counted. They were as follows:

| | *Pot* 1. | *Pot* 2. | *Pot* 3. |
|---|---|---|---|
| Ringed plant .. .. | 1 | 1 | 2 |
| Normal plant .. .. | 3 | 4 | 3 |

The diseased leaves on the control plants showed also a severer attack and a larger number of spots.

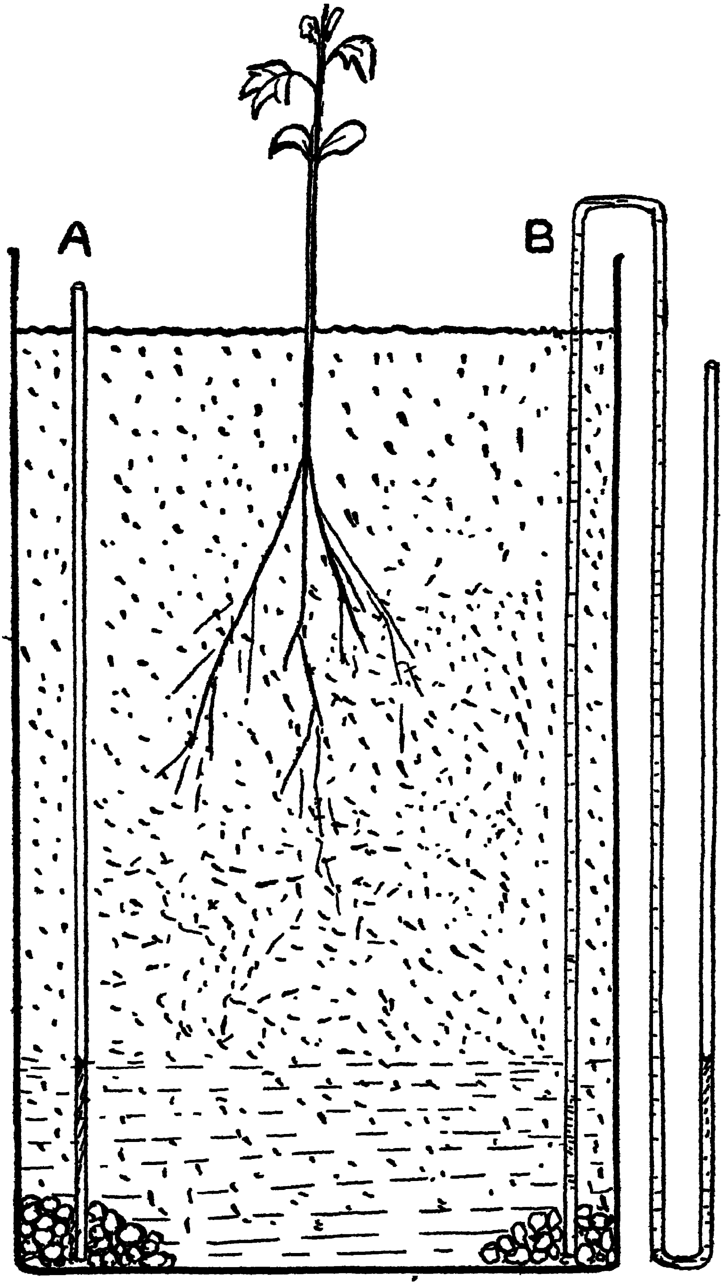
This result agrees well with the one obtained in the field.

A Pima plant from an early sowing, 16.10.26, which had at the apex some very old and mature, in fact almost senescent, leaves, was discovered to have a number of fresh young green shoots arising from nodes near the base. The whole was uniformly wetted with a suspension of bacteria on March 22. By March 28 numerous angular leaf spots appeared, but these were exclusively on the young leaves, thus again confirming the view that it is immature actively metabolizing tissue, that is in the nitrogenous phase, which is most susceptible to attack by *B. malvacearum.*

EXPERIMENTS IN CONNECTION WITH WATER RELATIONS.—It was desired to determine whether bacterial disease, like the majority of plant diseases, became more severe under very humid conditions. Brown[4] and Nakata[10] both state that the disease is favoured by wet weather; this might be due to one or both of two factors: (1) The increased facilities for spread in drops of water (Faulwetter's theory)[6] or (2) increased susceptibility of the plant under the wet conditions. It was to determine the latter point that these experiments were performed. A number of experiments were carried out to test the effect of increased atmospheric humidity on the progress of the disease, but without result. To determine this point accurately somewhat elaborate and costly apparatus would be necessary, and this was not available.

SOIL MOISTURE AND AERATION.—Work by Howard[8] in India has proved the considerable influence of various soil factors, more especially soil aeration, on the resistance of a plant to disease, and an experiment was designed to test the effect of various degrees of waterlogging on the resistance of cotton to *B. malvacearum.*

Seven 4-gallon kerosene cans were taken and waxed to prevent leakage. They were then provided each with two glass tubes, one a straight tube through which to convey water to the bottom of the can, and the other, reaching from the bottom of the can, was



A = Pipe for filling. B = Manometer.

bent over the edge, and again bent back at the level of the base of the can so as to form a U-tube and simple manometer, and thus to indicate on the outside the level of the water table inside.

Gravel was placed around the bottom ends of the glass tubes to prevent these becoming choked, and the cans then filled with sifted soil.

Freshly ginned Sea Island cotton seed was sown on March 8, five seeds in each pot; these were afterwards thinned out, and two plants were left in each pot.

On May 16, the soil in the pots was waterlogged up to various levels as follows:

*Pot* 1.—Control watered normally.

*Pot* 2.—Ditto.

*Pot* 3.—Waterlogged to within 10 inches of the surface of the soil—*i.e.*, there were about 2 inches of water in the bottom of the can.

*Pot* 4.—Waterlogged to within 8 inches of the surface.

*Pot* 5.—Waterlogged to within 6 inches of the surface.

*Pot* 6.—Waterlogged to within 4 inches of the surface.

*Pot* 7.—Completely waterlogged with small pools on the surface. These levels were kept more or less constant by refilling up to the marks every day. This was done through a piece of glass tubing, and a certain time was allowed to elapse to permit the water level to reach an equilibrium.

On May 17, at 6 p.m. (a dark, damp day), plants in pots 2-7 were sprayed as uniformly as possible with a suspension from 15 tubes of bacteria in 2 litres of water. On one plant in each pot every node and internode was pricked with a sterile needle.

On May 30 a number of spots had appeared, and definite lesions around most needle pricks on the inoculated plants. The control 1 remained perfectly healthy, and the punctures quite sterile.

By June 14 striking differences in the development and spread of the lesions up and down the stem from the punctures could be seen on the plants with different water tables.

On the control 2 (normally watered), which had been sprayed, the lesions were small, well-defined black areas, restricted to within a radius of a few millimetres of the actual puncture; on the plants with the saturated soil and high water table, or in a completely waterlogged soil, the lesions (especially those towards the apex of the plant) extended for some distance along the stem, and were bounded by a water-soaked area in which the tissue had not yet dried, though disorganized by the bacteria, showing that the attack was still progressing. Archibald[1] has shown that bacteria may exist in the apparently healthy tissue beyond a black-arm lesion. On the plants in pots 3, 4, and 5, the progress of the attack was intermediate between the control and the very wet plants.

The plants were cut down and carefully examined on June 17, and all the lesions occurring in the internodes above the third node measured to their nearest millimetre (the lesions at the nodes being irregular in shape would have been difficult to measure).

LENGTH OF BLACK ARM LESIONS ON INTERNODES.

| *Number of Plant.* | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| *Depths of Water Table.* | *Control Normally Watered.* | 10 *Inches.* | 8 *Inches.* | 6 *Inches.* | 4 *Inches.* | *Completely waterlogged.* |
| Lengths of lesions .. | 4 mms. | 3 mms. | 5 mms. | 3 mms. | 5 mms. | 7 mms. |
| | 5 „ | 5 „ | 5 „ | 6 „ | 18 „ | 5 „ |
| | 0* „ | 4 „ | 5 „ | 11 „ | 28 „ | 3 „ |
| | 3 „ | 10 „ | 5 „ | 6 „ | 12 „ | 25 „ |
| | 4 „ | 15 „ | 3 „ | 12 „ | 16 „ | 4 „ |
| | 4 „ | 10 „ | 12 „ | 5 „ | 45 „ | 34 „ |
| | 4 „ | 8 „ | 6 „ | 0* „ | 23 „ | 10 „ |
| | 5 „ | 10 „ | 10 „ | 13 „ | 6 „ | 22 „ |
| | 4 „ | 10 „ | 12 „ | 8 „ | — | 10 „ |
| | 4 „ | 11 „ | 12 „ | 4 „ | — | 15 „ |
| | 4 „ | 7 „ | 10 „ | — | — | — |
| | 7 „ | 0* „ | 3 „ | — | — | — |
| | — | 5 „ | — | — | — | — |
| | — | 25 „ | — | — | — | — |
| | — | 7 „ | — | — | — | — |
| Average length of lesion .. .. | 4·0 | 8·7 | 7·3 | 6·8 | 19·0 | 13·5 |

* 0 = puncture which did not become infected.

The measurements thus confirm the eye impression; in all the wet pots the average length of the lesions from a puncture was much greater than in the control which was grown with a normal amount of water. Again, the disease progressed further in those pots where the water table was high and the soil almost or completely waterlogged than in those which were wet but yet had the water table some distance below the surface. This suggests rather that the asphyxiation of the roots was the factor acting adversely on the plants and decreasing their resistance; but the general physiology and water relations of plants growing under waterlogged conditions are not well worked out, so hypothesis as to the actual cause of this result is not very useful, but the result itself is quite definite. The incidence of spotting on the leaves of these plants and of the second plant in each pot is in agreement with the severity of the stem lesions. The control plant showed no spots, and in the completely waterlogged pot each plant had four or five leaves badly spotted, especially along the vascular bundles.

The Black Arm, at the time of cutting down the plants, had not seriously affected their growth, but one large Sakel plant, which had been similarly waterlogged and inoculated on March 24, showed by the end of May the later stages of the disease. The whole upper part of the plant was dead—the leaves and bolls had all been shed and the stems were blackened and shrunken—a little new growth from the base alone showed that there was still life in the roots.

CONCLUSIONS.—Throughout this work it is from the point of view of the condition of the plant that the development of the disease has been considered, but the possibility of variations in the other organism (*i.e.* of the bacterium causing the disease) must not be overlooked. Re-isolations of the bacterium were made from time to time and tested out against the original, but showed no great variation in infective power. It is, of course, possible that different strains of the bacterium may exist in different localities, and this may explain the variations in the severity of attack on the same variety of cotton in different places, but we have no evidence on this point. While resistance to this disease seems definitely heritable, and many species and varieties are more or less completely resistant, yet it seems from the results above described, that the susceptibility to attack and the severity of the attack may be largely influenced by external factors in the environment of the plant.

An experiment that was performed to test the effect of artificial manures on the resistance of the plant gave results that suggested that the addition of quantities of nitrogen (in this case ammonium sulphate) to the soil definitely increased susceptibility. From this and from the results of the experiments on ringing, together with the fact that it is always the youngest leaves on a plant that take the attack worst, it may be concluded that it is the vegetative nitrogenous immature type of plant that is most liable to the disease. Probably, therefore, any operations, cultural or otherwise, which tend to bring earlier maturity would lessen the trouble from the disease.

The question of the spread of the disease in the field is quite an open one, and it may possibly prove not to be of great importance; isolated patches of badly infected plants may sometimes be seen in an otherwise healthy field.

The transmission of the infection internally in the seed has been definitely established by Archibald, so the necessity for sowing seed absolutely free from infection becomes of great importance, for the bacteria within the tissues of the seed cannot be killed by any methods which will not at the same time injure the seed. External sterilization can at the best be only partially successful, but may be useful for other reasons.

A wet or waterlogged soil appears definitely to encourage the progress of the disease, and this is one more reason for growing cotton only on land that is perfectly drained. In irrigated land also it is of extreme importance to have a satisfactory drainage system. The work of Balls has shown the disastrous effects of a rise in the water table from other points of view. The cotton plant has always been known to be most sensitive to any alteration in its soil water relations, and these seem to have an important effect also on its resistance to disease.

I wish to express my best thanks to Dr. Briton-Jones for his advice and kindly criticism.

The work of which the above is an account, was done in Trinidad while the writer was holding a Senior Studentship from the Empire Cotton Growing Corporation.

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# A CHANGE OF HEART

BY

W. GILHESPY.

CHANDU MULL was feeding the ants. Dressed in the long white cotton coat and tight trousers of the better class Hindu, and the small red turban of the Cutchi bunnia, he stopped whenever he saw a line of the busy little workers and sprinkled a handful of granulated sugar in their path. He smiled benignly as each ant seized a grain of sugar in its mandibles and hurried off to the communal abode.

Those who did not know Chandu Mull might have regarded him as a kindly man with a deep love for all created things, or perhaps a naturalist, engaged in an interesting study. They would have been wrong. Those who do know the wily Indian usurer and his ways would have guessed that he was a pitiless Shylock, who had just succeeded in adding to his store of ill-gotten wealth the last rupee he could wring from some wretched victim.

They would have been perfectly correct. The moneylender had had a busy day in the Civil Court. He had been awarded his pound of flesh with interest which, in some cases, ran as high as seven hundred per cent. He was richer by a few thousand rupees than he had been the day before, he had brought destitution on a few families, he knew that dozens of defrauded wretches would be calling down curses upon him, so he fed the ants with sugar by way of propitiating the gods. Then, to make quite sure that he was on the safe side, he dropped a *pie* into the lap of a blind beggar as well. As twelve *pies* equal a penny, he had made rather a good bargain with his deities.

One who knew him only too well gave him a *salaam* so profound that it was a thinly veiled insult. Chandu Mull's return salute was so kindly that it seemed like a benison. The cultivator who had greeted him was so deeply in his debt that he could afford to forgive him.

" That," explained Rahimatullah to his companion, " is a *ghiddar ka bheta* (son of a jackal). More greedy than the pig of the jungle is he, more merciless than the wolf."

" It hath been told to me that he giveth freely in charity."

" Of a truth he giveth—but why? He helped to build hostels for the poor. In one of them liveth Kumal Khan, who was a man of wealth ere he began to borrow money from Chandu Mull. Who bringeth poverty on the land as the locusts bring the famine? Chandu Mull gave ten thousand rupees towards the building of the Leper Hospital. Those unbelievers think that, because the lepers hasten to the tomb by a path of torture, it is given unto them to call down blessings or curses upon the sons of men. Therefore doth he help them."

"Dost thou owe him money?"

"Hearken, and I will tell thee how he dealeth with those who fall into his power. When the sirkar gave me land on the new canal, the Deputy Commissioner sahib told to us that it would be good that we should grow cotton. Those zemindars who had grown it before also said that they had made great gain thereby, and sowed it again. I had not the money to buy bullocks and pay for labour, so I grew maize and bajri, gaining but half as many rupees as those who grew cotton. Therefore, the next year I went to Chandu Mull, and borrowed money that I might buy more bullocks and implements for the cotton-growing. Freely he lent, saying unto me: 'When the cotton is sold, thou canst repay,' and I promised.

"At the time of the cotton picking I could have repaid him, but I wished to sow more and more land with cotton, and needed yet more bullocks, also I desired to build me a house on mine land. This I showed to that wily one, and he answered:

"'Let the debt stand; what is that between me and thee? Build thou thine house, and may peace and prosperity abide therein. Sign thou this bond, which showeth that the interest hath not been paid, and I will wait yet another year.'

"So I signed, believing that he spake truth. No, I did not read it. When did such as I ever learn to read? At that time I knew not that he was a thief and a liar.

"The crops were good, and the cotton prices were high, so I gave him two hundred and thirty rupees, believing that I still owed him some forty rupees.

"'I will pay thee the balance when the maize is sold,' I said unto him, and he agreed.

"'Sign thou this bond for the remainder,' he said, with sweetness in his smile, but only greed and cunning in his heart.

"When I took him forty rupees that I might be clear of debt, he told me that there still remained three hundred rupees to be paid. Then my anger arose, and I told him that I had paid heavily, and would pay no more. Still that wicked one smiled, and said naught, for he is a son of Shaitan, and verily his father hath given unto him great cunning.

"For two years he said nothing. I, being but a fool in such matters, thought that he would trouble me no more. Then, when the cotton was ready for the picking, he came with men to gather it—my cotton, saying that I owed him money, and that I had signed a bond, giving him a lien thereon.

"'Thou art a liar, and the son of Shaitan,' I said unto him, and took my *phaora* (hoe) to beat him. But he ran swiftly, such as he being but cowardly dogs. Then he sent me a summons which said that I owed him nearly six hundred rupees, and that I must go to the court.

"I went. He had many bonds which I had signed when he told me they were but for putting off the payments. But the judge said that they were bonds I had signed for more and more money, and that I must pay fifteen rupees each month until all is paid. For many months I paid, now I have not paid for three months, and again he will drag me to the court, so that I shall fall upon ruin."

He did—he rushed towards it. Rahimatullah brooded over his wrongs till grief drove him to despair. That which rankled most in his untutored mind was the galling knowledge that he had walked blindly into the trap the usurer had prepared with careless contempt for his victim's stupidity. Added to the humiliation was the fear that he would lose the land which, to men like him, ranked next to his children in his affections.

Unused to the ways of courts, he sat under a tree near the court-house from early morning till late afternoon. Then, just before the case was called, his enemy was driven up to the door in his private carriage, a handsome bay mare equipped with silver-plated harness between the shafts.

"I—I and fools like me have paid for a beautiful carriage in which that spawn of hell may drive to court and tell lies and lies and lies, until I shall not have the wherewithal to provide bread for my children"; and as the bunnia alighted, Rahimatullah stepped forward and felled his enemy to the ground. Fortunately for him, the by-standers intervened, or he would have ended his career on the scaffold.

While he nursed his hatred among the under-trial prisoners, the civil surgeon examined the unconscious moneylender, and asked Major Blake, of the Royal Army Medical Corps, for aid. Blake shook his head.

"'Tis a case for a specialist," he said in low, grave tones. "I've trepanned some bad cases—but it's touch and go with this chap. Smythe's the man for this job. How's this chap fixed for filthy lucre?"

"All right, I guess. Moneylender, owns cotton mills—what d' y' call them?—ginning mills. Pretty well off."

"You bet. Better start the telegraph wires humming, you've got no time to waste, and it's a hundred to one chance after all. Let me know when Smythe comes, will you?"

"There's a chance of recovery," the great man declared when the operation was finished. "The injury *seems* to be merely superficial, but—time alone can tell. Let me know how he progresses."

Very slowly the patient improved. Johnson, the civil surgeon, watched his progress with keen interest, as the usurer groped his way back from the shadows.

"No business and no worry," he insisted, when the usurer's brothers came to take him away. "Don't you imagine he's out of danger, and don't let him think he's not. Yes, yes, he seems to be improving, and he is improving, but we can't be quite sure—yet. Avoid trouble and excitement, and—don't let him worry."

Progress was steady. Chandu Mull made no attempt to worry over business matters, seeming quite content to let his alert brain rest. While he was awake he took a quick interest in matters that had formerly been beneath his notice. He chatted freely and intelligently with casual visitors, took an interest in his neighbours' affairs, but slept most of the time.

"Let him sleep all he wants to," the civil surgeon ordered. "He needs it—let him sleep. Why worry when he's getting better every day? Haven't you any idea what he has gone through? Give him time, and don't worry." The brothers went away only half satisfied.

Chandu Mull was the brains of their extensive business, which consisted of buying "raw" cotton and ginning and baling it. Cotton-growing was, in that district which lay to the north and west of Meeraganj, a new industry. India lives by agriculture. Anything that helps agriculture conduces to her prosperity, and enormous sums are spent in the construction of irrigation canals. As vast areas of waste land are brought under cultivation, every effort is made to induce the cultivators to grow cotton—more and more cotton.

Chandu Mull's father had been a wealthy zemindar, and one of the first to see the possibilities of growing cotton for export from that district. It had long been grown on a small scale for local use, just as it is now. But cotton for export was quite a different proposition. There was not only the lint that could be exported, but he foresaw an ever-increasing demand for cotton seed.

The old man took a trip to Bombay, and travelled round the cotton-growing districts. He went to the experimental farms, and saw cotton from various countries being grown, saw cotton of longer staple and finer quality than he had ever dreamed of. He saw the ginning factories and examined the machinery, he studied the methods and made mental notes of potential improvements. He had no engineering skill, but he had a wonderful faculty for making money, and he knew there was money in cotton.

He had gone to Bombay for a month—and stayed four. It was time well spent. For fifteen hours daily he was learning something about cotton. If he were not watching its cultivation, he was in or around the factories. When work was over for the day, he spent the evenings among men who lived for and by cotton. The old man talked of cotton and dreamt about it. Then he went back to Meeraganj to grow it.

He called upon the Deputy Commissioner with a suggestion. The Indian Government desired the zemindars to grow cotton for export. Cotton would help them and the country—without a doubt. He, too, intended to grow cotton. He had spent several months in the cotton-growing districts studying the subject at first hand, and he told the Deputy Commissioner more about cotton than he had ever known before.

Well, cotton-growing would give new life to the country, there was no doubt about that. But preparation was necessary. Ginning and baling factories would be necessary, men with capital, enterprise, and initiative would be needed to build and run them, and he suggested that *he* was the man—provided the Government gave the land near the station for the purpose.

Yes, the Deputy Commissioner thought he could promise that, and waited for what was to come next. It came. The old speculator thought that the cotton-growing scheme would benefit if he received a few zareebs of land. The average Indian cultivator has very little initiative, and, as he pointed out, needs to be led. If he could grow large areas of cotton at a big profit, the others would be emboldened to follow his example.

"Rather a tall order," mused the Deputy Commissioner. "Modesty won't keep old Kundu Mull back. He's a moneylender and a sharper, but he's a hustler. Not much use coaxing and bullying old Abraham, Isaac, and Jacob to abandon methods that Noah favoured unless they can get their cotton handled."

So Kundu Mull was granted a site on which to erect his factory, with the promise of about half the land he had asked for as soon as the factory was in being.

Chandu Mull inherited only a share of his father's wealth, but he inherited his keen intelligence and ruthless desire of acquisition. His brothers were smart men; there are few smarter traders anywhere than the bunnias of Northern India, but their elder brother towered above them. They had been under his rule so long, that their powers of initiative had almost become atrophied. Now the master mind seemed to derive as much pleasure in mending a child's toy or in helping a neighbour as in solving a knotty business problem.

Yet he could smooth their difficulties with a word. His powers were not impaired, but his methods had altered with his outlook. The old Chandu Mull had rapped out his orders, this one made requests. In the thrust and parry of Oriental trade he had been so swift to take reprisals that few had cared to cross swords with him. Now he bore losses with equanimity, showed his brothers where they had laid themselves open to attack, but was more inclined to admire a rival's smartness than to retaliate. He had always given freely to charity, lavishly when he had an end in view, now he gave generously but judiciously, even when his donations brought him neither advertisement nor increased power. This, his brothers considered, was proof positive of senility. Johnson had no patience with them.

"What *do* you expect?" he demanded. "He has made tremendous progress, his recovery was a miracle—all things considered. No, I won't certify him as unfit to give evidence against Rahimatullah. I've got to be there myself, and I'll know if the strain is too much for him. I'm busy. Good morning."

Rahimatullah's friends had pooled their resources and engaged a *vakil* (pleader) to defend him. He had advised his client to plead "Guilty," and relied for mitigation of sentence on his proofs that the man had been driven to despair by the usurer's extortionate demands.

Chandu Mull made his task very easy. Johnson had been watching the usurer's pained expression with consuming interest. When he asked leave to address the court, the doctor waited breathlessly.

"These bonds and my books show that the prisoner was harshly treated," he admitted. "I—I cannot quite—understand it. I have been very ill, and there are some things which I cannot remember—as yet. I will need time to go into the matter, and—and make amends—if necessary. As for the assault, if your honour will take into consideration all that the accused has suffered, and regard a fine as adequate punishment, I—I will—help him to pay it."

Everyone gazed at the usurer, and his brothers gasped their dismay. The members of the bar showed their surprise, and the magistrate tried to hide his. Frank admission of error in an Oriental criminal court was something unprecedented. A moneylender's anxiety to pay an assailant's fine took their breath away.

A month later Johnson received Chandu Mull's brothers.

" He is back at business," they announced gloomily.

" Glad to hear it."

" But he is mad, and we shall all be ruined," his brothers wailed. " His illness has destroyed his reason. In charity he has spent much money."

" He always did; he is a very wealthy man."

" He gave publicly, and in the way of business. When he sought election to the municipal council, or——" A nudge from his brother's elbow stopped his indiscretions.

" Ah well," he continued, " charity to the poor bringeth down blessings from the gods. But indeed he is wasting money—throwing it away."

" Throwing it away ?"

" He remits the interest due on loans. He pays full prices for the cotton he buys, when he owns the only factory in the district and could compel the farmers to sell at any price he chose. Oh, he has lost much money."

" Why have you come to me ? What do you want me to do ?"

" If the sahib will give a certificate that Chandu Mull is—is unfit to have the control of the money matters——"

Johnson grinned insinuatingly, and drew his chair a little closer.

" How much would such a certificate be worth to a wealthy firm like yours ?" he asked with a wink.

" It would be worth—any sum the sahib likes to charge," the other whispered eagerly. " We would gladly pay anything to——"

" I guess you would. Now listen to me. I have been watching your brother very, very closely. Most interesting case I ever heard of—a triumph for the surgeon who performed the operation. A case that will be studied by generations of surgeons yet unborn. A record—understand ? Bigger men than I'll ever be would give a lot for the privilege of watching your brother's progress. You can bet I haven't missed much.

" Very well. During the last month your firm got out of the wheat slump with a loss of only two thousand rupees, while smaller firms lost three times as much, and wealthy concerns are in Queer Street. Remember seeing me in the mill when your brother was superintending the erection of the new hydraulic press for baling cotton? Eh? Could you have done it? How much are you saving daily by it since it started? You cleared eight thousand since your brother returned. He did finance that young fellow who is experimenting with Punjab-American cotton seed, but how much does your firm stand to win if you can grow cotton of longer staple and with a higher proportion of kapas to seed? He did go easy with those chaps who couldn't pay him, but how much would you have lost if you had ruined them, and got no more cotton from them?

" Want me to certify him as irresponsible, do you? Get out—my toes are itching, and—I wear number nine boots. Get out." They got out.

Johnson was reading a letter from the famous surgeon when Blake strolled in.

" Your patient has had a most wonderful recovery," the great man wrote, " and I am greatly indebted to you for your close observation and your interesting accounts. Trepanning has often been followed by deplorable changes in the mental and moral attitude and powers of the patient. This, I believe, is the first authenticated case of a man recovering full physical and mental powers while attaining a definitely higher moral standard."

" Just so," said Blake, after reading the letter. " Just so. Look here, young man, I've just thought of a way to regenerate this downtrodden country, and free the improvident cultivators from the toils of the moneylenders, leave them free to grow cotton till a photograph of the fields would look like a snapshot of a snow scene. You run round the country with Rahimatullah and Smythe. Give the cultivator a serviceable shillelagh, and tell him to get every usurer ready for trepanning, then let Smythe operate on them. What?"

# OBSERVATIONS ON A FUNGUS DISEASE AND AN INSECT PEST OF COTTON

BY

H. K. HEWISON AND J. E. SYMOND.

DURING the course of investigations on cotton, conducted whilst the writers were resident at the Imperial College of Tropical Agriculture, observations were made *inter alia* upon the incidence of Alternaria leaf spot (*A. longipedicillata*, Reich), and of the insect pest *Dysdercus* (Cotton Stainer).

The essence of the main experiment was a study of the growth and developmental responses to local conditions of the above and below ground portions of various types of cotton, and for the purpose three blocks of land were each subdivided into thirty-six plots, and planted on the chequer-board system. The following five varieties of cotton were employed: Sea Island, Red Kidney, Ishan, Cawnpore, Sakel.

Seed was sown 3 by 3 feet, two seeds per hole, and the three blocks (A, B, and C) were planted on November 11 and 25, and December 9, 1926 respectively. Vacancies were filled on the seventh day from sowing. The recorded rainfall for the period was: November, 4·95 inches, December, 5·29 inches, January, 7·43 inches, February, 7·12 inches, and March, 1·24 inches.

The variation between the growth of the plants in the various plots was most marked, and it subsequently transpired that, during the preparation of the area, certain employees had, in moments of misplaced enthusiasm, levelled up various shallow depressions with soil from a nearby very heavily manured plot. This, of course, created a set of conditions quite unanticipated when the scheme of work was drawn up, but, partly as a result of the protracted rains, these very conditions gave rise to a series of most interesting results. The majority of these results are outside the scope of this paper, but it is necessary to note here that, in the regions of the greatest additions of the manured soil, the plants made abnormal and prolonged vegetative growth, whereas, in the original soil of the area, growth was poor, and indicative of unsatisfactory soil conditions. Furthermore, whilst the continued rains appeared to promote growth in the former areas, the plants of the latter bore permanent traces of a series of checks to growth which, together with other evidence, led to the assumption of unsatisfactory soil moisture conditions.

In conjunction with these results, the incidence of Alternaria leaf spot assumes considerable interest, and an interpretation of the values and the variations indicated by the numerals of the attached table of infection becomes a somewhat intricate problem when the individuality of each plant is recognized, and full weight is given to the variety and the complexity of the factors governing the plant's susceptibility.

Nowell, in discussing the disease (*Diseases of Crop Plants in the Lesser Antilles*, pp. 284-285), quoting R. C. Faulwetter, states: "Artificial inoculations show the fungus to be a weak parasite, and able to infect healthy tissue only under the most favourable conditions."

Such a statement leads one to the conclusion that those plants of this experiment which were affected were growing under conditions which were either (*a*) not optimum for the particular plant concerned, or (*b*) extremely favourable for the spread and development of Alternaria. It would probably be more correct to assume a combination of the two.

On reference to the rainfall figures, together with attached table of infection, it will be noticed that, during the period February 1 to March 1, when there was a continuance of the abnormal rainy weather, there was, over the majority of plots, a definite increase in the incidence of the leaf spot. There were, however, certain plots where very different results were obtained; not only did some indicate that the spread of the disease had been checked despite the constant rain, but some actually showed a diminution in the percentage of attack.

A detailed examination of the various plots leads one to conclude that these apparently divergent results are not so contradictory as they appear at first glance. It was noted in the main experiment in connection with the growth of plants that, within the limits of quite a small area, a given period of rainfall will have a variety of influences upon development; with certain plants the rain is associated with increased growth; with others there is a marked retardation, even to the degree of a check from which the individuals do not recover for some time.

The three blocks of cotton (A, B, and C) were, at the time of this examination, fifteen, thirteen, and eleven weeks old, and the limited root development of many of the plants, coupled with unsatisfactory soil conditions, must have entailed degrees of root asphyxiation as the rains continued.

That with plants more favourably situated the previous rains had facilitated root penetration to regions of soil richer in plant food material, a feature calculated to lead to further growth as the supply of rain remained, is only what might be expected. Such being the case, it is safe to assume that, at the periods of these diverse responses, the conditions of the plants pertaining to the degree of their susceptibility to attack by a parasite such as Alternaria must have been equally variable.

It should be noted, however, that while incidence appears directly correlated with lack of vigour, it is not necessarily inversely proportionate to maximum growth, but rather to optimum growth. Many plants growing vigorously during this period, in a condition compatible with a low carbohydrate-nitrogen ratio, were markedly subject to attack. Whether this is attributable to the internal constitution of the plant or to some external factor or factors associated with abnormal vegetative growth, it is impossible to say. The observations are, in any case, of considerable practical interest.

The degree of attack over plots of such individuals is clearly seen on reference to the following units of the table of infection:

| | |
|---|---|
| **Red Kidney** .. .. .. .. | A-13; B-13. |
| **Sea Island** .. .. .. .. | B- 1; B-16. |
| **Sakel** .. .. .. .. .. | A-14; B-14. |
| **Ishan** .. .. .. .. .. | A-15; B-15; A-25; B-25. |

With the advent of the drier period of March, there was a marked falling off in the numbers of plants attacked and in the degree of the attack. This condition continued throughout, excepting in those plots where there were evident signs of senescence. In these, the incidence of Alternaria was again high.

The comparatively low degree of attack of plants of the Cawnpore variety is noteworthy. (See table on p. 51.)

### OBSERVATIONS ON *Dysdercus* (COTTON STAINER).

On the same three blocks of cotton as those used for the main experiment a series of observations were made on the incidence of *Dysdercus,* with a view to ascertaining the susceptibility to attack of the different varieties, the influence, if any, of the date of sowing, and, finally, the varieties of *Dysdercus* prevalent during the period.

The insects were first seen on February 25, 1927, on plants of Block (A), which was then fifteen weeks old (sown on November 11, 1926).

## TABLE.—INCIDENCE OF ALTERNARIA LEAF SPOT.

| *Block.* | | *Date of Count.* | *Degree of Infection per plot.* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1–12 | 1/2/27 | 4 | — | 1 | 6 | 6 | 0 | — | 4 | 7 | 6 | 6 | 17 |
| | 13–24 | | 3 | 2 | 3 | 6 | — | 6 | 2 | 8 | 15 | — | 4 | 16 |
| | 25–36 | | 4 | 1 | — | 0 | 1 | 4 | 7 | 7 | 15 | 12 | 7 | — |
| B | 1–12 | 1/2/27 | 5 | — | 2 | 7 | 6 | 5 | — | 8 | 3 | 8 | 11 | 11 |
| | 13–24 | | 3 | 2 | 3 | 3 | — | 5 | 0 | 6 | 13 | — | 3 | 10 |
| | 25–36 | | 4 | 0 | — | 4 | 2 | 8 | 13 | 15 | 9 | 8 | 8 | — |
| A. | 1–12 | 1/2/27 | 2 | — | 3 | 5 | 5 | 5 | — | 7 | 2 | 9 | 14 | 14 |
| | 13–24 | | 2 | 4 | 2 | 5 | — | 4 | 2 | 7 | 15 | — | 0 | 14 |
| | 25–36 | | 0 | 2 | — | 4 | 2 | 7 | 14 | 14 | 17 | 12 | 15 | — |
| C | 1–12 | 1/3/27 | 1 | — | 4 | 3 | 9 | 1 | — | 7 | 10 | 7 | 9 | 17 |
| | 13–24 | | 2 | 2 | 5 | 6 | — | 6 | 3 | 8 | 14 | — | 6 | 15 |
| | 25–36 | | 4 | 3 | — | 2 | 2 | 4 | 9 | 7 | 15 | 14 | 9 | — |
| B | 1–12 | 1/3/27 | 6 | — | 2 | 4 | 4 | 5 | — | 6 | 3 | 7 | 16 | 14 |
| | 13–24 | | 4 | 3 | 5 | 7 | — | 6 | 2 | 6 | 18 | — | 5 | 12 |
| | 25–36 | | 6 | 2 | — | 3 | 3 | 8 | 13 | 17 | 11 | 10 | 10 | — |
| A | 1–12 | 1/3/27 | 3 | — | 3 | 5 | 8 | 4 | — | 6 | 2 | 10 | 16 | 13 |
| | 13–24 | | 4 | 5 | 3 | 5 | — | 4 | 2 | 7 | 14 | — | 2 | 15 |
| | 25–36 | | 3 | 2 | — | 2 | 2 | 7 | 13 | 15 | 16 | 15 | 18 | — |
| C | 1–12 | 1/4/27 | 0 | — | 2 | 2 | 6 | 0 | — | 2 | 7 | 8 | 7 | 12 |
| | 13–24 | | 3 | 0 | 5 | 5 | — | 4 | 1 | 7 | 9 | — | 2 | 12 |
| | 25–36 | | 4 | 0 | — | 2 | 0 | 2 | 4 | 4 | 10 | 13 | 6 | — |
| B | 1–12 | 1/4/27 | 3 | — | 1 | 2 | 3 | 2 | — | 4 | 3 | 4 | 7 | 11 |
| | 13–24 | | 2 | 2 | 5 | 4 | — | 5 | 1 | 4 | 12 | — | 2 | 10 |
| | 25–36 | | 4 | 0 | — | 2 | 1 | 5 | 11 | 15 | 7 | 10 | 9 | — |
| A | 1–12 | 1/4/27 | 2 | — | 4 | 3 | 5 | 4 | — | 3 | 1 | 8 | 14 | 10 |
| | 13–24 | | 2 | 1 | 1 | 4 | — | 3 | 2 | 7 | 11 | — | 0 | 12 |
| | 25–36 | | 3 | 0 | — | 0 | 2 | 5 | 9 | 12 | 12 | 12 | 10 | — |
| C | 1–12 | 14/4/27 | 4 | — | 1 | 5 | 7 | 4 | — | 4 | 3 | 5 | 7 | 12 |
| | 13–24 | | 5 | 3 | 5 | 3 | — | 4 | 1 | 5 | 9 | — | 1 | 9 |
| | 25–36 | | 4 | 4 | — | 2 | 0 | 2 | 6 | 2 | 6 | 13 | 2 | — |
| B | 1–12 | 14/4/27 | 3 | — | 0 | 4 | 4 | 6 | — | 7 | 2 | 5 | 8 | 11 |
| | 13–24 | | 2 | 3 | 6 | 4 | — | 5 | 1 | 6 | 10 | — | 1 | 10 |
| | 25–36 | | 6 | 0 | — | 3 | 0 | 4 | 10 | 12 | 9 | 8 | 5 | — |
| A | 1–12 | 14/4/27 | 3 | — | 0 | 5 | 6 | 8 | — | 5 | 4 | 7 | 12 | 10 |
| | 13–24 | | 5 | 2 | 4 | 6 | — | 3 | 2 | 11 | 10 | — | 2 | 11 |
| | 25–36 | | 3 | 0 | — | 3 | 3 | 6 | 8 | 12 | 10 | 12 | 10 | — |

| | *Variety.* | *Number of Plots in A, B, and C throughout.* |
|---|---|---|
| Scheme of Chequer Plotting | Sea Island .. .. .. | 1, 10, 16, 18, 32, 35. |
| | Cawnpore .. .. .. | 3, 9, 19, 23, 26, 29. |
| | Sakel .. .. .. | 4, 8, 14, 24, 30, 33. |
| | Ishan .. .. .. | 5, 12, 15, 21, 25, 31. |
| | Red Kidney .. .. | 6, 11, 13, 20, 28, 34. |
| | *Not Planted* .. .. | *2, 7, 17, 22, 27, 36.* |

At intervals of a few days counts were made over the various plots in order to note the progress of the invasion, and after a lapse of about three weeks, the entire population was killed off. Ten days later—*i.e.*, March 25—counts were again made, and these were continued until the area had become completely infested.

The details of these counts will be found in the attached table; the figures in roman denote adult *Dysdercus* ; those in italics record the presence of insects in both the adult and nymphal stages.

This table shows, in the first planted block (A), that there was a decided preference during the first month for the Asiatic variety Cawnpore. There is little difference in the moderate infection of Sakel, Sea Island, and Ishan, whilst the Red Kidney appears to have a comparative immunity.

This order of infection is readily accounted for by the degree of maturation of the varieties of cotton, the Asiatic type ripening earliest, whilst Red Kidney, a tree cotton, is late in development. It cannot, therefore, be said that there is any degree of susceptibility to attack amongst these varieties of cotton, all becoming infested on maturity.

Differential sowing does not appear to affect this order, nor does it reduce the liability to attack. Examination of the data in the second and third planted blocks (B and C) shows a recurrence of the early preference for Cawnpore and the immunity of Red Kidney. The degree of infestation is slightly more rapid in these later planted blocks, probably attributable to the proximity of the more mature and heavily infested cotton.

It is interesting to note that nymphs had not appeared on any variety other than Cawnpore until after March 25th, at which date the plants of all varieties in block (A) were nineteen weeks old; and the possibility of using this variety as a trap crop in small cultivations presents itself. *Dysdercus* are easily seen and collected from the Asiatic cotton on account of the upright habit and thin foliage of this variety.

Though the argument might be advanced that *Dysdercus* would be attracted earlier, it is probable that the numbers of these insects infesting a crop of New World cotton would be considerably reduced by interplanting with occasional strips of an Asiatic variety, from which the insects should be constantly collected. An experiment on these lines would prove of interest.

Two varieties of *Dysdercus* only were observed, *D. Howardi* and *D. Howardi minor*. The latter occurred slightly later in the season than the former, but in approximately equal numbers.

## TABLE OF DYSDERCUS COUNTS.

| | 1*st* *March.* | 4*th* *March.* | 10*th* *March.* | *15*th* *March.* | 25*th* *March.* | 10*th* *April.* | 28*th* *April.* |
|---|---|---|---|---|---|---|---|
| **Block A.** | | | | | | | |
| Cawnpore .. .. | 194 | *316* | *736* | *975* | *182* | *414* | *720* |
| Egyptian .. .. | 24 | 25 | 59 | 192 | 94 | *518* | *1880* |
| Sea Island .. .. | 16 | 5 | 39 | 187 | 80 | *515* | *1,610* |
| Ishan .. .. | 5 | 3 | 34 | 178 | 112 | *643* | *1,730* |
| Red Kidney .. | — | — | 5 | 28 | 16 | 78 | *343* |
| **Block B.** | | | | | | | |
| Cawnpore .. .. | 12 | 29 | 110 | 256 | *119* | *225* | *475* |
| Egyptian .. .. | — | 1 | 7 | 43 | 62 | *334* | *830* |
| Sea Island .. .. | — | — | — | 35 | 37 | *196* | *810* |
| Ishan .. .. | — | — | — | 40 | 61 | *274* | *620* |
| Red Kidney .. | — | — | — | 2 | 2 | 82 | *280* |
| **Block C.** | | | | | | | |
| Cawnpore . .. | — | 6 | 15 | 56 | *56* | *87* | *118* |
| Egyptian .. .. | — | — | — | 7 | 1 | 78 | *204* |
| Sea Island .. .. | — | — | — | 2 | — | 94 | *288* |
| Ishan .. . | — | — | — | 5 | 7 | 88 | *240* |
| Red Kidney .. | — | — | — | — | 3 | 15 | 20 |

* On this date all *Dysdercus* killed off.

Figures in roman type denote adult *Dysdercus*, those in italics insects in both adult and nymphal stages.

*Received July,* 1927.

# COTTON STATISTICS.—XII

## CONSUMPTION AND STOCKS

BY

JOHN A. TODD, M.A., B.L.

The statistics of consumption and stocks of American cotton as at the end of last season, have this year been the subject of an unusual amount of controversy. Colonel Hester, of the New Orleans Cotton Exchange, published his usual estimate of the season's consumption of American cotton early in August, making the total 16,375,000 bales, excluding linters (of which he estimated the consumption at 1,053,000 bales). When the Federation figures came out in September it appeared that their figure was only 15,780,000, excluding linters. This of itself would have mattered very little, because the difference is not really so very great, and is partly accounted for by the fact that Hester includes consumption of cotton elsewhere than in cotton mills—*e.g.*, for mattresses, etc. Hester's high consumption figure, however, necessarily made his carry-over figure at the end of the season correspondingly low (6,592,000 bales, excluding linters), but as the Federation merely publish their statistics of world *mill* stocks, and do not attempt to compile a complete carry-over, the difference might have passed without attracting notice, but for the fact that the U.S. Department of Agriculture (Bureau of Agricultural Economics) published an estimate of the carry-over at 7,838,000 bales, excluding linters. The result was a controversy between Hester and the Bureau, waged mainly over the question of the value of the Federation statistics as compared with Hester's, and the conclusion seems to be that Hester almost certainly under-estimated the world's mill stocks outside of the U.S.A., which proved to be much higher than anyone had expected. The following table gives the totals for some years back, showing the difference between the Federation and Hester on consumption, and between Hester and the Census Bureau and our own figures of the carry-over. The difference between our total (7,448,000 bales, excluding linters) and the Census Bureau figures is largely due to the fact that the latter have included an estimate of stocks in and afloat to Eastern ports (375,000 bales), but we have not attempted to do so, as there is no reliable information as to the amount of these stocks, and, after all, the total amount is not very important.

CONSUMPTION AND CARRY-OVER OF AMERICAN COTTON.

(000's of Running Bales, excluding Linters.)

| | *Consumption.* | | *Carry-Over (End of Season).* | | |
|---|---|---|---|---|---|
| | *Federation.* | *Hester.* | *J.A.T.* | *Hester.* | *Census Bureau.* |
| 1919–20 .. .. | 12,439 | 12,340 | 5,656 | 5,216 | — |
| 1920–21 .. .. | 10,033 | 9,816 | 9,141 | 8,699 | 9,172 |
| 1921–22 .. .. | 12,728 | 12,240 | 5,028 | 4,547 | 5,123 |
| 1922–23 .. .. | 12,594 | 11,989 | 3,235 | 2,396 | 3,065 |
| 1923–24 .. .. | 11,080 | 10,731 | 2,665 | 2,089 | 2,664 |
| 1924–25 .. .. | 13,270 | 13,509 | 3,324 | 2,826 | 3,306 |
| 1925–26 .. .. | 13,736 | 14,257 | 5,358 | 5,111<br>5,378* | 5,631* |
| 1926–27 .. .. | 15,780 | 16,375 | 7,448 | 6,952* | 7,838* |

* Including Eastern stocks.

A year ago we gave an analysis of the world's consumption of cotton, pre-war and post-war, with diagrams, which brought out the very unsatisfactory position of the United Kingdom relatively to almost all other countries. The Federation figures now given for the season 1926–27 unfortunately show no improvement on that position. Once more the U.S.A., Continent, and Asia have consumed a great deal more American cotton, while we have actually consumed less. The same is substantially true of other kinds of cotton, our only gain being in the consumption of sundries.

The table of the U.S. consumption of cotton shows once more a very large increase, almost every month last season having shown new record figures, while the current season, so far as it has gone, is carrying on the same tendency.

The world's carry-over of Egyptian cotton at the end of last season was the highest ever recorded.

## TABLE I.—WORLD'S CONSUMPTION OF ALL KINDS OF COTTON.

(From the Statistics of the International Federation.)

(*Running Bales, 000's Omitted.*)

| *Variety.* | *Season.* | *U.K.* | *Continent.** | *U.S.A.* | *Asia.* | *All Others.* | *Totals.* |
|---|---|---|---|---|---|---|---|
| *American* (including linters in U. S. A., as shown in brackets) .. | 1911–12 | 3,734 | 5,137 | 5,160 (238) | 507 | 140 | 14,678 |
| | 1912–13 | 3,667 | 4,593 | 5,553 (303) | 519 | 124 | 14,456 |
| | 1919–20 | 2,980 | 2,538 | 6,345 (342) | 709 | 209 | 12,781 |
| | 1920–21 | 1,678 | 2,802 | 5,193 (516) | 684 | 192 | 10,549 |
| | 1921–22 | 2,275 | 3,593 | 6,252 (639) | 1,031 | 216 | 13,367 |
| | 1922–23 | 1,919 | 3,293 | 6,968 (646) | 859 | 201 | 13,240 |
| | 1923–24 | 1,695 | 3,199 | 5,890 (537) | 661 | 172 | 11,617 |
| | 1924–25 | 2,344 | 4,009 | 6,576 (659) | 772 | 228 | 13,929 |
| | 1925–26 | 2,093 | 4,194 | 6,980 (804) | 1,012 | 261 | 14,540 |
| | 1926–27 | 2,077 | 4,797 | 7,685 (802) | 1,756 | 267 | 16,582 |
| *Indian* .. .. | 1911–12 | 45 | 801 | 9 | 3,014 | — | 3,869 |
| | 1912–13 | 53 | 813 | — | 3,073 | 2 | 3,941 |
| | 1919–20 | 58 | 444 | 12 | 3,196 | — | 3,710 |
| | 1920–21 | 39 | 770 | 10 | 3,749 | 2 | 4,570 |
| | 1921–22 | 55 | 824 | 11 | 4,032 | — | 4,922 |
| | 1922–23 | 107 | 977 | 21 | 4,276 | 1 | 5,382 |
| | 1923–24 | 201 | 1,247 | 27 | 3,922 | 7 | 5,404 |
| | 1924–25 | 183 | 1,108 | 31 | 4,165 | 34 | 5,521 |
| | 1925–26 | 168 | 1,063 | 30 | 4,273 | 38 | 5,572 |
| | 1926–27 | 82 | 855 | 28 | 4,203 | 28 | 5,196 |
| *Egyptian* .. | 1911–12 | 374 | 374 | 120 | 23 | 2 | 893 |
| | 1912–13 | 393 | 380 | 134 | 17 | 12 | 936 |
| | 1919–20 | 441 | 173 | 216 | 24 | — | 854 |
| | 1920–21 | 237 | 136 | 106 | 22 | 13 | 514 |
| | 1921–22 | 336 | 208 | 151 | 38 | 9 | 742 |
| | 1922–23 | 393 | 272 | 175 | 40 | 10 | 890 |
| | 1923–24 | 469 | 354 | 149 | 39 | 16 | 1,027 |
| | 1924–25 | 431 | 350 | 128 | 49 | 13 | 971 |
| | 1925–26 | 391 | 334 | 136 | 42 | 17 | 920 |
| | 1926–27 | 369 | 401 | 159 | 51 | 25 | 1,005 |
| *Sundries* .. | 1911–12 | 120 | 1,764 | 20 | 749† | 1,060 | 3,713 |
| | 1912–13 | 161 | 2,128 | 32 | 798† | 818 | 3,937 |
| | 1919–20 | 141 | 116 | 160 | 1,077 | 614 | 2,108 |
| | 1920–21 | 70 | 1,039 | 67 | 981 | 672 | 2,829 |
| | 1921–22 | 199 | 716 | 114 | 980 | 708 | 2,717 |
| | 1922–23 | 351 | 616 | 98 | 1,262 | 850 | 3,177 |
| | 1923–24 | 353 | 529 | 76 | 1,351 | 576 | 2,885 |
| | 1924–25 | 277 | 896 | 66 | 1,523 | 785 | 3,547 |
| | 1925–26 | 370 | 1,619 | 58 | 1,308 | 1,103 | 4,458 |
| | 1926–27 | 482 | 1,239 | 64 | 1,362 | 753 | 3,900 |
| *All Kinds* .. | 1911–12 | 4,274 | 8,075 | 5,309 | 4,293† | 1,202 | 23,153 |
| | 1912–13 | 4,274 | 7,914 | 5,719 | 4,407† | 956 | 23,270 |
| | 1919–20 | 3,620 | 3,271 | 6,733 | 5,006 | 823 | 19,453 |
| | 1920–21 | 2,024 | 4,747 | 5,376 | 5,436 | 879 | 18,462 |
| | 1921–22 | 2,865 | 5.341 | 6,528 | 6,081 | 933 | 21,748 |
| | 1922–23 | 2,770 | 5,158 | 7,262 | 6,437 | 1.062 | 22,680 |
| | 1923–24 | 2,718 | 5,329 | 6,142 | 5,973 | 771 | 20,933 |
| | 1924–25 | 3,235 | 6,363 | 6,801 | 6,509 | 1,060 | 23,968 |
| | 1925–26 | 3,022 | 7,210 | 7,204 | 6,635 | 1,419 | 25,490 |
| | 1926–27 | 3,010 | 7,292 | 7,936 | 7,372 | 1,073 | 26,683 |

* No returns from Russia and Austria in 1919–20.

† Including China from a private estimate in 1911–12 and 1912–13

## TABLE II.—U.S. CONSUMPTION OF COTTON BY VARIETIES.

(000's of Running Bales: Foreign in Equivalent 500-lb. Bales.)

| | | *Total.* | *Upland.* | *Egyptian.* | *Other Foreign.* | *Sea Island.* | *American Egyptian.* | *Linters not Included.* |
|---|---|---|---|---|---|---|---|---|
| *Seasons' Totals.* | 1912–13 | 5,483·3 | 5,195·6 | 201·3 | 31·7 | 54·8 | — | 303·0 |
| | 1913–14 | 5,577·4 | 5,301·4 | 151·1 | 43·2 | 81·7 | — | 307·3 |
| | 1914–15 | 5,597·4 | 5,295·9 | 181·2 | 40·8 | 79·4 | — | 411·8 |
| | 1915–16 | 6,397·6 | 5,998·0 | 269·3 | 47·7 | 82·6 | — | 880·9 |
| | 1916–17 | 6,788·5 | 6,376·0 | 259·2 | 59·1 | 94·3 | — | 869·7 |
| | 1917–18 | 6,566·5 | 6,296·8 | 136·4 | 47·4 | 85·9 | — | 1,118·8 |
| | 1918–19 | 5,765·9 | 5,517·6 | 126·1 | 50·0 | 51·2 | 21·1 | 457·9 |
| | 1919–20 | 6,419·7 | 5,914·2 | 323·1 | 93·6 | 43·0 | 45·9 | 342·5 |
| | 1920–21 | 4,892·7 | 4,641·5 | 159·2 | 56·6 | 18·7 | 16·8 | 516·3 |
| | 1921–22 | 5,909·8 | 5,554·7 | 226·3 | 70·5 | 9·0 | 49·4 | 639·0 |
| | 1922–23 | 6,666·1 | 6,250·8 | 262·3 | 81·5 | 6·3 | 65·2 | 646·1 |
| | 1923–24 | 5,680·6 | 5,312·0 | 223·6 | 104·0 | 4·9 | 36·0 | 536·7 |
| | 1924–25 | 6,193·4 | 5,894·5 | 191·5 | 84·4 | 4·0 | 19·0 | 658·8 |
| | 1925–26 | 6,455·9 | 6,161·7 | 204·1 | 76·0 | 2·3 | 11·7 | 803·8 |
| | 1926–27* | 7,202·7 | 6,861·7 | 239·7 | 80·5 | — | 20·8 | 802·2 |
| *Monthly Figures, 1925–26.* | August .. | 451·2 | 427·8 | 16·2 | 6·2 | 0·3 | 0·8 | 65·3 |
| | September | 483·1 | 456·3 | 18·0 | 7·9 | 0·2 | 0·7 | 71·6 |
| | October .. | 544·1 | 518·2 | 17·5 | 7·4 | 0·3 | 0·7 | 77·0 |
| | November | 543·5 | 524·0 | 12·6 | 5·9 | 0·2 | 0·8 | 71·5 |
| | December | 576·2 | 553·2 | 16·2 | 5·7 | 0·3 | 0·8 | 61·2 |
| | January .. | 582·3 | 555·9 | 18·4 | 6·8 | 0·3 | 0·9 | 62·2 |
| | February.. | 565·1 | 539·3 | 19·1 | 5·6 | 0·2 | 0·9 | 59·4 |
| | March .. | 635·9 | 605·4 | 21·8 | 7·6 | 0·1 | 1·0 | 65·6 |
| | April .. | 577·7 | 552·3 | 18·2 | 5·8 | 0·1 | 1·3 | 67·4 |
| | May .. | 516·4 | 492·4 | 16·9 | 5·6 | — | 1·5 | 65·2 |
| | June .. | 518·6 | 496·0 | 14·7 | 6·6 | — | 1·4 | 70·3 |
| | July .. | 461·7 | 441·2 | 14·6 | 5·0 | — | 1·0 | 66·8 |
| *Monthly Figures, 1926–27.** | August .. | 500·6 | 476·9 | 17·2 | 5·1 | — | 1·4 | 73·5 |
| | September | 570·6 | 539·5 | 22·9 | 6·4 | — | 1·8 | 74·8 |
| | October .. | 568·4 | 539·4 | 20·8 | 6·2 | — | 1·8 | 75·4 |
| | November | 584·0 | 559·3 | 16·4 | 6·3 | — | 1·9 | 63·0 |
| | December | 605·2 | 580·7 | 17·0 | 5·5 | — | 2·0 | 54·0 |
| | January .. | 604·6 | 578·6 | 17·4 | 7·0 | — | 1·5 | 55·1 |
| | February | 590·4 | 565·7 | 17·3 | 5·8 | — | 1·7 | 60·3 |
| | March .. | 694·2 | 663·4 | 21·8 | 7·3 | — | 1·8 | 68·2 |
| | April .. | 619·1 | 581·1 | 19·5 | 6·7 | — | 1·7 | 67·0 |
| | May .. | 633·0 | 601·4 | 22·0 | 7·8 | — | 1·8 | 72·8 |
| | June .. | 662·6 | 625·6 | 26·0 | 9·7 | — | 1·3 | 70·0 |
| | July .. | 569·3 | 540·2 | 21·4 | 6·6 | — | 1·1 | 69·1 |
| 1927.* | August .. | 633·4 | 603·0 | 22·4 | 6·7 | — | 1·3 | 74·0 |
| | September | 627·3 | 599·3 | 19·6 | 7·1 | — | 1·3 | 78·3 |
| | October .. | 612·9 | 585·2 | 19·3 | 6·9 | — | 1·5 | 73·2 |

* Subject to revision.

## TABLE III.—WORLD'S MONTHLY CARRY-OVER OF *AMERICAN* COTTON.

(IN THOUSANDS OF RUNNING BALES, INCLUDING LINTERS IN U.S.A., ALSO SEA ISLAND AND AMERICAN EGYPTIAN, BUT NOT FOREIGN COTTON.)

| *End of* | *Stock and Afloat.* |  | *U.S.A.* |  | *Monthly Totals.* | *Federation.* | *Half-Yearly Totals.* | *U.S.A.* | *End of Season Totals.* |
|---|---|---|---|---|---|---|---|---|---|
|  | *U.K.* | *Continent.* | *Mill Stocks.* | *Public Warehouses.* |  | *Other Mill Stocks.* |  | *Elsewhere.* |  |
| 1912, August .. | 508 | 406 | 786 | 556 | 2,256 | 1,305 | 3,561 | 350 | 3,911 |
| 1913, August .. | 423 | 282 | 699 | 492 | 1,896 | 1,011 | 2,907 | 375 | 3.282 |
| 1914, August .. | 627 | 489 | 687 | 562 | 2,365 | — | — | 320 | — |
| 1915, July .. | 1,238 | 753 | 1,491 | 1,839 | 5,321 | — | — | 850 | — |
| 1916, July .. | 707 | 516 | 1,591 | 1,150 | 3,964 | — | — | 450 | — |
| 1917, July .. | 237 | 332 | 1,521 | 1,069 | 3,159 | — | — | 440 | — |
| 1918, July .. | 173 | 164 | 1,541 | 1,924 | 3,802 | — | — | 315 | — |
| 1919, July .. | 806 | 486 | 1,519 | 2,402 | 5,213 | — | — | 1,150 | — |
| 1920, July .. | 878 | 474 | 1,485 | 2,262 | 5,099 | 1,066 | 6,165 | 500 | 6,665 |
| 1921, July .. | 839 | 805 | 1,222 | 3,874 | 6,740 | 1,137 | 7,877 | 1,960 | 9,837 |
| 1922, July .. | 558 | 562 | 1,266 | 1,468 | 3,854 | 1,243 | 5,097 | 185 | 5,282 |
| 1923, July .. | 187 | 206 | 1,109 | 903 | 2,405 | 713 | 3,118 | 310 | 3,428 |
| 1924, July .. | 228 | 310 | 739 | 695 | 1,972 | 688 | 2,660 | 220 | 2,880 |
| 1925, July .. | 401 | 373 | 916 | 516 | 2,206 | 1,046 | 3,252 | 270 | 3,522 |
| August .. | 264 | 292 | 706 | 1,041 | 2,303 | — | — | — | — |
| September | 273 | 471 | 887 | 3,113 | 4,744 | — | — | — | — |
| October | 458 | 822 | 1,247 | 4,510 | 7,037 | — | — | — | — |
| November | 670 | 990 | 1,517 | 5,226 | 8,403 | — | — | — | — |
| December | 804 | 1,052 | 1,806 | 5,614 | 9.276 | — | — | — | — |
| 1926, January | 802 | 905 | 1,905 | 5,216 | 8,828 | 1,121 | 9,949 | — | — |
| February | 779 | 857 | 1,936 | 4,783 | 8,355 | — | — | — | — |
| March .. | 736 | 791 | 1,866 | 4,208 | 7,601 | — | — | — | — |
| April .. | 706 | 682 | 1,730 | 3,571 | 6,689 | — | — | — | — |
| May .. | 702 | 604 | 1,526 | 3,002 | 5,834 | — | — | — | — |
| June .. | 644 | 531 | 1,333 | 2,429 | 4,937 | — | — | — | — |
| July .. | 579 | 406 | 1,155 | 1,946 | 4,086 | 959 | 5,045 | 595 | 5,640 |
| August .. | 512 | 354 | 959 | 1,721 | 3,546 | — | — | — | — |
| September | 554 | 620 | 964 | 3,301 | 5,439 | — | — | — | — |
| October | 727 | 824 | 1,255 | 5,458 | 8,264 | — | — | — | — |
| November | 990 | 1,153 | 1,563 | 6,552 | 10,258 | — | — | — | — |
| December | 1,195 | 1,444 | 1,851 | 6,514 | 11,004 | — | — | — | — |
| 1927, January | 1,311 | 1,555 | 1,951 | 6,102 | 10,919 | 1,193 | 12,112 | — | — |
| February | 1,335 | 1,486 | 2,063 | 5,491 | 10,375 | — | — | — | — |
| March .. | 1,363 | 1,603 | 2,136 | 4,547 | 9,649 | — | — | — | — |
| April .. | 1,346 | 1,561 | 2,056 | 3,720 | 8,683 | — | — | — | — |
| May .. | 1,260 | 1,433 | 1,944 | 2,914 | 7,551 | — | — | — | — |
| June . | 1,125 | 1,214 | 1,749 | 2,202 | 6,290 | — | — | — | — |
| July .. | 1,011 | 1,079 | 1,523 | 1,856 | 5,469 | 1,695 | 7,164 | 625 | 7,789 |
| August .. | 906 | 816 | 1,216 | 2,197 | 5,135 | — | — | — | — |
| September | 805 | 960 | 1,192 | 3,979 | 6,936 | — | — | — | — |
| October .. | 782 | 1,174 | 1,401 | 5,455 | 8,812 | — | — | — | — |
| November | 764 | 1,408 | — | — | — | — | — | — | — |

## TABLE IV.—WORLD'S CARRY-OVER OF *EGYPTIAN* COTTON.

(Kantars 000's Bales Converted at 7·5 Kantars (Europe) and 5·0 Kantars (U.S.A.).)

| *End of* | *Stock and Afloat.* | | *U.S.A.* | | *Alexandria.* | *Monthly Total.* | *Federation.* | *Half-Yearly Total.* |
|---|---|---|---|---|---|---|---|---|
| | *U.K.* | *Continent.* | *Mills.* | *Warehouses.* | | | *Half-Yearly.* | |
| 1912, August .. | 302 | 30 | 424* | — | 350 | 1,106 | 1,387 | 2,493 |
| 1913, August .. | 418 | 31 | 354 | 13 | 491 | 1,307 | 1,485 | 2,792 |
| 1914, August .. | 467 | 10 | 259 | 26 | 766 | 1,528 | — | — |
| 1915, July .. | 758 | 71 | 484 | 126 | 1,074 | 2,513 | — | — |
| 1916, July .. | 351 | 50 | 617 | 296 | 104 | 1,418 | — | — |
| 1917, July .. | 431 | 27 | 376 | 213 | 589 | 1,636 | — | — |
| 1918, July .. | 541 | 185 | 180 | 157 | 1,727 | 2,790 | — | — |
| 1919, July .. | 526 | 170 | 185 | 79 | 2,060 | 3,020 | — | — |
| 1920, July .. | 466 | 79 | 587 | 514 | 601 | 2,247 | 1,365 | 3,612 |
| 1921, July .. | 688 | 158 | 345 | 296 | 1,992 | 3,479 | 1,005 | 4,484 |
| 1922, July .. | 835 | 148 | 314 | 267 | 1,669 | 3,233 | 1,252 | 4,485 |
| 1923, July .. | 859 | 129 | 447 | 265 | 1,096 | 2,796 | 1,200 | 3.996 |
| 1924, July .. | 517 | 128 | 259 | 63 | 384 | 1,351 | 1,155 | 2,506 |
| 1925, July .. | 443 | 75 | 253 | 57 | 411 | 1,239 | 1,103 | 2,342 |
| August .. | 383 | 60 | 209 | 39 | 393 | 1,084 | — | — |
| September .. | 345 | 98 | 180 | 42 | 660 | 1,325 | — | — |
| October .. | 473 | 187 | 130 | 30 | 1,576 | 2,396 | — | — |
| November .. | 638 | 210 | 100 | 31 | 1,808 | 2,787 | — | — |
| December .. | 698 | 202 | 136 | 48 | 2,251 | 3,335 | — | — |
| 1926, January .. | 668 | 217 | 228 | 106 | 2,267 | 3,486 | 1.275 | 4,761 |
| February .. | 743 | 157 | 250 | 123 | 2,316 | 3,589 | — | — |
| March .. | 802 | 173 | 322 | 138 | 2,137 | 3,572 | — | — |
| April .. | 893 | 202 | 334 | 135 | 2,073 | 3,637 | — | — |
| May.. .. | 1,043 | 195 | 329 | 149 | 1,903 | 3,619 | — | — |
| June .. | 1,065 | 150 | 330 | 150 | 1,843 | 3,538 | — | — |
| July .. | 930 | 120 | 321 | 143 | 1,544 | 3,058 | 1,185 | 4,243 |
| August .. | 930 | 75 | 305 | 88 | 1,101 | 2,499 | — | — |
| September .. | 848 | 82 | 263 | 59 | 1,261 | 2,513 | — | — |
| October .. | 758 | 202 | 201 | 37 | 1,859 | 3,057 | — | — |
| November .. | 938 | 225 | 180 | 38 | 2,574 | 3,955 | — | — |
| December .. | 953 | 180 | 185 | 65 | 3,004 | 4,387 | — | — |
| 1927, January .. | 885 | 158 | 242 | 82 | 3,303 | 4,670 | 1,058 | 5,728 |
| February .. | 1,102 | 158 | 244 | 72 | 3,215 | 4,791 | — | — |
| March .. | 1,275 | 180 | 277 | 67 | 3,286 | 5,085 | — | — |
| April .. | 1,320 | 203 | 263 | 87 | 2,982 | 4,855 | — | — |
| May.. .. | 1,395 | 143 | 282 | 67 | 3,086 | 4,973 | — | — |
| June .. | 1,372 | 143 | 289 | 73 | 2,716 | 4,593 | — | — |
| July .. | 1,260 | 143 | 295 | 66 | 2,392 | 4,156 | 1,358 | 5,514 |
| August .. | 1,088 | 127 | 276 | 67 | 1,816 | 3,374 | — | — |
| September .. | 908 | 112 | 261 | 88 | 2,240 | 3,609 | — | — |
| October .. | 780 | 165 | 275 | 85 | 2,842 | 4,147 | — | — |
| November .. | 735 | 210 | — | — | 3,210 | — | — | — |

* Total foreign—details not given.

# NOTES ON CURRENT LITERATURE

## *COTTON IN INDIA.*

1. THE COTTON INDUSTRY. (Abstr. from *Cotton*, October 22, 1927.) The textile industry is the greatest manufacturing industry of India as regards its production, the capital invested, and the number of people employed, states the *Indian Textile Journal*. The trade in textile materials, machinery, and stores is one of the largest individual divisions in the import trade. The cotton mills, 330 in number, work 8,500,000 spindles and 160,000 looms, employ 360,000 work-people, and use 2¼ million bales of cotton annually. The capital invested in them is more than 35 crores of rupees in shares, and there is another 30 crores in reserves. These mills produce at present 800 million lbs. of yarn and 2,000 million lbs. of cloth annually, valued at over 75 crores of rupees. About half the textile needs of the country are supplied by them.

2. AGRICULTURAL IMPLEMENTS SUITABLE FOR THE USE OF THE INDIAN CULTIVATOR. By A. P. Cliff. (*Agr. Jnl. of India*, xxii., 4, 1927, p. 287.) An important contribution to the question of adapting modern implements to the use of the ryot.

3. THE EFFECT OF TEMPERATURE AND HUMIDITY ON COTTON SPINNING, WITH PARTICULAR REFERENCE TO CONDITIONS IN BOMBAY. By A. J. Turner. (Abstr. from *Bull. No.* 9, *Tech. Ser.*, no. 4, Indian Central Cotton Comm. Technological Laboratory, 1927.) The following are the chief conclusions arrived at by the author: (1) *Comfort.*—That for comfort the normal conditions, about (but not below) 80° F. and about (but not below) 60 per cent. R.H., are more satisfactory than either of the extreme conditions.

(2) *Workability.*—That for workability of the material in processing, the dry conditions are undesirable, as they lead to fuzzy material, which occasionally gives some trouble. Normal conditions are satisfactory throughout. Monsoon conditions give rise to excessive web shedding, and rather more waste in the card, but otherwise cause no trouble.

(3) *Appearance of Yarn.*—That yarn spun under medium-dry conditions is oozy and very crimpy; yarn spun under normal conditions is less oozy and less crimpy than the yarn spun under medium-dry conditions; yarn spun under monsoon conditions is very smooth and free of crimpiness. These differences practically disappear when the yarn is conditioned.

(4) *Strength.*—That within the limits of temperature and humidity within which these tests were carried out, it is impossible to lay down any hard-and-fast rule as to which conditions (medium-dry, normal, or monsoon) will give rise to the strongest yarns, the differences for the most part being inappreciable.

(5) *General.*—That the processing of the material in cotton spinning, and the quality of the spun yarn are not seriously affected by the spinning processes being carried out at relative humidities as low as 40 per cent.; but that, taking all things together, the normal conditions are probably best for carrying out cotton-spinning tests.

(6) That Bombay conditions are practically ideal for the processing of the material in cotton spinning.

4. DACCA MUSLIN MANUFACTURE. (*Text. Mercury*, 1927, 77, 191. Abstr. from *Summ. of Curr. Lit.*, vii., 16, 1927, M. 24.) The method of manufacturing Dacca muslin seems to have been lost. It is not apparently known if the cotton received any previous preparation, or what apparatus was used in its manufacture. A type of cotton has been found both in East Bengal and North Bengal which answers very closely to Roxburgh's description of the Dacca muslin cotton plant. If this is the muslin cotton, it possesses no particularly fine qualities. The Nawab Bahadur of Dacca has offered to give a small piece of the genuine material for microscopic examination.

## *COTTON IN THE EMPIRE (EXCLUDING INDIA).*

5. ASIA: CEYLON. From the *Admin. Rpt. of the Dir. of Agr. for* 1926 recently received, we learn that the cotton crop in the Hambantota District was very promising at the beginning of the year, but yields did not come up to expectations owing to a considerable amount of boll and flower-bud shedding. The total crop of cotton grown in various districts of the island was estimated at 3,000 cwts., of which 2,604 cwts. were produced in the Hambantota District. The increase in this district is shown in the following table:

| | | |
|---|---|---|
| 1922–23 .. .. .. .. | 15½ | cwts. seed cotton. |
| 1923–24 .. .. .. .. | 710 | „ „ „ |
| 1924–25 .. .. .. .. | 1,225 | „ „ „ |
| 1925–26 .. .. .. .. | 2,600 | „ „ „ |

There is keen interest in cotton-growing by the peasant growers, and they greatly appreciate the money which is paid directly into their hands for the crop. The expansion of the industry is largely due to the efforts of Mr. Harbord and his staff in the Hambantota District, and to the support of Mr. S. P. Wijetunge, Mudaliyar of East Giruwa pattu. In addition to the above districts, cotton was also grown during the year in Walapane, Uva, the Matale District of the Central Province, and in the North-Western Province.

6. In *Sessional Paper* xxv., 1927, dealing with the "Cotton Purchase Scheme," Mr. Stockdale, the Director of Agriculture, indicates the line of development which is taking place—viz., the cultivation of cotton in blocks rather than in isolated chenas of small acreage, the establishment of buying centres, and the testing of rotation crops. He states that the future requirements of the industry are: an earlier maturing type of cotton, as village cultivators will not sow cotton until the kurakkan chenas have been sown; further work with rotations; the establishment of a ginnery; the establishment of another buying centre at Middeniya; the encouragement of cotton-growing in West Giruwa pattu, where there has been for some time a desire for lands to be assigned for cotton cultivation; and the guarantee of the price at its present level for the next three or four years.

7. *Cotton Cultivation.* (Abstr. from *Trop. Agriculturist*, lxix., 2, 1927, p. 91.) The development of cotton in the Hambantota District necessitates the stationing of a senior subordinate officer in that district. The greatest amount of development is likely to take place along the coast or around Middeniya.

8. MALAYA. *Cotton in Malaya.* (*Malayan Agr. J.*, 1926, xiv., 6. Abstr. from *Int. Rev. of the Sci. and Pract. of Agr.*, xviii., 7, 1927, T. 391.) Trial plots of Sea Island cotton in the province of Wellesley and in various districts of Pahang indicated that the cultivation of this crop to any large extent was unlikely, owing to its liability to the attack of pests.

9. AFRICA: KENYA COLONY. *Cotton Cultivation.* (Abstr. from *Ann. Rpt. of the Dpt. of Agr.*, 1926, recently received.) Twenty tons of selected Uganda seed

were issued from the Sio Ginnery in Central Kavirondo, and issues of local seed were made from other ginneries and buying centres. Owing to low prices, a much smaller acreage was planted in 1926. It is suggested that efforts should be made early in the season to induce the natives to cultivate cotton, as good returns can be obtained from a crop to which proper attention is given.

The pink bollworm now appears to be established on the coast, but is, to a great extent, controlled by a Braconid parasite. Recommendations are made which it is thought will, if effectively carried out, greatly reduce the incidence of this and other pests of cotton.

10. NIGERIA. *Cotton Cultivation.* (Abstr. from *Trop. Agriculture,* iv., 8, 1927, p. 152.) The efforts of the Agricultural Department to isolate an improved strain of indigenous cotton for Southern Nigeria have been successful, and a cotton of unprecedented value on the West Coast has been produced. This cotton is of a type vegetatively suited to the native agricultural system, and its yield is satisfactory. About one ton of seed is available for small-scale distribution during the coming season. There is every reason for believing that this cotton will revolutionize the industry in Southern Nigeria when the initial difficulties of extension work have been overcome.

11. *Cotton Ginneries.* (Abstr. from the *Rpt. of the Agr. Dpt.,* 1926, recently received.) Three new ginneries have been erected during 1926-27—viz., Gusau, Funtua, and Karadua, while one at Mallamfashi is still under construction. The Funtua ginnery is of particular interest, because it is of a new type. The output per saw is 8·19 lb. of lint per hour, as compared with 5 lb. per hour of the old twelve-inch saws. This difference in output is due to an increased rate of revolution—750 r.p.m. in the new machines, as against 350 r.p.m. in the old ones.

12. *Cotton Seed Farm at Daudawa.* (Abstr. from the *Rpt. of the Agr. Dpt.,* 1926, p. 16.) This farm was opened at the beginning of the year. It is managed and financed by the Empire Cotton Growing Corporation, in close co-operation with the department, for the purpose of multiplying the "improved strains" of American cotton evolved by the Botanist at Samaru, after they have been tested at the latter place. Some 1,200 acres have been reserved for the farm. For the 1926 crop 180 acres were cleared and 160 acres cropped, the yields obtained being very satisfactory for a first year. A large seed farm for the multiplication of improved strains of cotton is very badly needed in the Northern Provinces, but, naturally, to be of any really practical use, at least 1,000 acres of cotton are required. It is further hoped that eventually the farm will serve a valuable purpose by providing an opportunity for trying out, on a larger scale, new methods evolved at the departmental farms, and will thus serve as an intermediate stage between the department and ordinary farmers. The criticism of the staff on the farm, when they try out such new methods, should be very valuable to the department.

13. RHODESIA (SOUTHERN). *Cotton.* (Extracted from the *Rhod. Agr. Jnl.,* xxiv., 8, 1927, p. 830.) We give the following extract from the Editorial: "The Colony has recently been honoured with visits from Sir James Currie, K.B.E., C.M.G., of the Empire Cotton Growing Corporation, and Sir William Himbury of the British Cotton Growing Association, each of whom made a comprehensive tour of the cotton-growing areas and acquired a first-hand knowledge of the conditions under which the crop is grown. Their views as to the suitability of the Colony for the growing of cotton have been given in the daily Press, and are distinctly favourable. Briefly, they are to the effect that there are many parts of the Colony where cotton can be grown successfully, providing suitable varieties and good seed are planted. The Government and the Corporation are alive to

the necessity for this, and every effort is being made at the Gatooma Cotton Breeding Station to evolve a type suited to our particular conditions. Such work, naturally, is a slow process, for exhaustive tests must be carried out before a particular type can be adopted. The past few seasons have demonstrated the fact that Improved Bancroft cotton, the variety which has been almost universally used, is not maintaining its strength, while it is particularly susceptible to jassid attack. The future of cotton in this Colony depends upon the finding of a type which possesses the qualities lacking in Improved Bancroft, and farmers may rest assured that everything possible is being done in this respect.

"Experience of the past few years has proved one important fact, and that is the value of cotton as a rotational crop with maize. For this reason alone a number of farmers annually put down an area to cotton, and results have fully justified the practice. We believe, however, that cotton is destined to assume far greater importance in the agricultural practice of this Colony than as a rotational crop. Bad seasons, a slump in prices, and the difficulty in obtaining good seed, have had their effect on production, but these are factors which are not permanent. The prime factor is, as Sir James Currie and Sir William Himbury tell us, that the conditions in this Colony are suited to the growing of cotton, and there is reason for believing that, when the difficulties we have enumerated have been overcome, cotton will take its place with maize and tobacco as one of the principal crops of the Colony."

14. *Cotton Seed for Planting.* By G. S. Cameron. (*Rhod. Agr. Jnl.*, xxiv. 9, 1927, p. 965.) Mr. Cameron states that the chief hindrance to successful cotton-growing in Southern Rhodesia would appear to be the jassid. As a proof of this, it may be mentioned that jassid-resistant strains and selections have grown and produced well at Gatooma this year, when most of the other cotton succumbed. Now that the chief cause of the trouble has been identified, it is only a matter of time until jassid-resistant strains of cotton can be propagated and multiplied in sufficient quantity to permit a general distribution of seed which can be relied upon to give a good crop. It is estimated that in two years' time there will be sufficient seed for a limited acreage.

15. SIERRA LEONE. *Cotton Cultivation.* (*Bull. Imp. Inst.*, 25, 1927, p. 298. Abstr. from *Summ. Curr. Lit.*, vii., 20, 1927, E. 60.) Trials are in progress with different varieties of cotton to discover a type suitable to Sierra Leone. Seasonal trials are also being carried out to discover the best time to sow. Lengupa, Sunflower, and Quande cotton have been sown. The climate of Sierra Leone is divided into two distinct periods—namely, rains from May to October, with about 80 to 90 inches of rain, and dry from November to April, with approximately 15 to 20 inches of rain. The object is to establish either a long-season cotton, which will be planted in June or July, and yet withstand the heavy rains, or a short-season cotton, which, when planted in August or September, will come to maturity by January. Seed selection on the indigenous Quande cotton has been in progress for the last two seasons. There has been a marked improvement in the quality of cotton.

16. SOUTH AFRICA. *Cotton Cultivation.* (Abstr. from *Afr. Sugar and Cot. Jnl.*, i., 7, 1927, p. 25.) The new ginnery of the Tugela Estates was opened officially on October 5. At the opening ceremony Mr. C. J. Homewood, Senior Cotton Grader for the Union, said that Weenen was one of the best, if not the best, cotton-growing area in the Union. There had been only one failure of the crop, and that was caused through excessive drought. He added that thanks were due to the experts of the Empire Cotton Growing Corporation for the splendid work they were doing in providing pure and better seed.

17. *Cotton Growing in Southern Africa and the Rhodesias. A Report on a Tour undertaken in Southern and Central Africa by Sir James Currie, Mr. J. S. Addison, and Mr. H. C. Jefferys, April–June,* 1927. (Empire Cotton Growing Corporation, London.) A very interesting report, not suffering from the common fault of too great length. The most marked feature in it is the prominence given to the very good results obtained by Mr. Parnell in breeding jassid-resistant varieties of cotton at the Corporation's Plant Breeding Station at Barberton. These are well illustrated in the photographs that are reproduced. Once these varieties can be fully tested, and seed of the best distributed upon a large scale, a very important step will have been taken towards the establishment of a large industry in cotton cultivation in South Africa.

The general impression gathered is a favourable one, and progress is likely to be steady though slow.

The proposals at the end of the report include the equipping of Barberton Station on a larger scale, and the vigorous prosecution of work upon crop rotation.

18. *The Union of South Africa as a Source for Increasing our Raw Cotton Supplies.* By Sir William Himbury. (British Cotton Growing Association, Manchester.) An account of a recent trip to South Africa undertaken by Sir William Himbury and Mr. H. Astley-Bell, and one which gives a general picture of affairs in the cotton world there that does not differ very greatly from that given in the Corporation's report above reviewed. The grading at Durban was thought to be rather too elaborate for the small amount of cotton at present available. Attention is called to the necessity for increasing the equipment and staffing of the Barberton Station. The development of native cultivation in the way that it is seen in Uganda and other parts of tropical Africa appears not to be feasible at present.

19. *Cotton's Future in South Africa. Including a Brief Summary of Standard Cultural Methods.* (*Afr. Sugar and Cot. Jnl.*, i., 6, 1927, p. 21.)

20. ZULULAND. *Crop Rotation.* By E. H. T. Powell. (*Afr. Sugar and Cotton Jour.*, i., 5, 1927, p. 26.)

21. SUDAN. *Cotton Cultivation in the Gezira.* (Abstr. from the *Ann. Rpt. of the Cent. Econ. Board,* 1926-27, p. 3.) The year 1926 provides some striking contrasts in the field of economic affairs. It has shown to the full the immediate value both to the native population and to the Government of the substitution of a reliable for a variable supply of water for cultivation—by means of the Gezira Irrigation Scheme—which for the first time last year was brought into operation on a large scale. Eighty thousand feddans of the initial area of 100,000 feddans were cultivated under cotton, and remarkably successful results were obtained. The yield of ginned cotton averaged at 4·85 kantars per feddan, or 463 lb. per acre, and gave a substantial cash return to the tenants, whose share in the net proceeds of the crop amounted to nearly £E1,000,000. Here in this district are to be found all the makings of an assured prosperity, which has been thrown into high relief by the plight of the rest of the northern and central part of the country, where the people have been struggling against the hardships consequent on the poor rainfall and low Nile of 1925, accentuated by a second failure of the rains of 1926. It is thus a matter for great satisfaction that the Gezira Scheme, in its first year of major operation, though still incomplete, so far from imposing any financial burden on the country, has proved a profitable asset both directly and indirectly, and has stood the Sudan in good stead during a period of economic strain.

The total value of exports during the year has increased from £E3,801,348 to £E4,876,236, an increase of £E1,074,888, or 28 per cent., as compared with

1925; but the value of exports other than cotton has declined from £E2,045,531 to £E1,773,851, a decrease of £E271,680, or 13 per cent. On the other hand, the value of cotton and cotton seed exported has increased from £E1,755,817 to £E3,102,385, an increase of £E1,346,568, or 43 per cent. Cotton has, therefore, more than compensated for the decline in other exports.

22. *Cotton in the Bahr el Ghazal District.* From the same report we learn that in the Bahr el Ghazal Province the Dinkas are beginning to show a real interest in cotton-growing, realizing that by growing sufficient cotton they can pay their taxes without parting with any of their cattle—a most important factor for cotton propaganda in the Dinka country. Unlike last season, when all the cotton was carried to the river by the natives themselves, this season, 1926-27, inland marketing centres have been set up, conveniently placed, and with easy access to the main areas of cultivation. The cotton will be baled at these centres, and transported to Shambe on the river by motor transport.

23. TANGANYIKA. *Report of the Dept. of Agr. for the year ending March* 31, 1927. (Published by the Crown Agents for the Colonies, 4, Millbank, London, S.W. 1. Price 2s. 6d.) We have recently received a copy of the above report, which contains much useful information concerning cotton-growing in the Territory, under the following heads: Improvement of the quality of cotton; marketing improvement and extension; work at the Agricultural Stations; statistics of crop production and exports; control of pests and diseases.

24. *The Amani Research Institute.* (Abstr. from *East Afr.*, 4, 164, 1927, p. 248.) A lecture delivered by the Director, Mr. W. Nowell, before the Association of Economic Biologists, giving the history of the Amani Institute and an outline of the research work it is hoped to carry out there.

25. TOGOLAND (BRITISH). *Cotton Cultivation.* (*Col. Rpt.*, 23, 17-20, London, 1926. Abstr. from *Coton et Culture Coton*, ii., 1, 1927, p. 42.) Experiments have been carried out at the Agricultural Station at Kpedshu with a view to acclimatizing a variety of cotton of rapid growth and early maturity suitable for cultivation in the country. The most promising varieties would appear to be a cross between " Meade " and " Allen " cottons and one called " Soncho," which was introduced by the Germans some time before the war, and which is well acclimatized, and a popular type with the natives. Two hybrids of Upland and Soncho would also appear to be promising varieties for cultivation.

26. UGANDA. In the *Ann. Rpt. of the Dpt. of Agr.*, 1926, recently received, cotton-growing in the Teso and Lango districts is dealt with in the report of the Senior Agricultural Officer (p. 18). The Cotton Botanist describes the selection and other experimental work carried out at the Serere Experimental Station (p. 23). The report of the Acting Mycologist (p. 30) deals mainly with seedling diseases, and that of the Assistant Entomologist (p. 27) with the following pests: bollworms, cotton stainers, jassids, and cutworms.

27. *Cotton Cultivation.* The latest report from the Protectorate is to the effect that weather conditions became more favourable after the middle of September, and prospects for both cotton and food crops improved considerably with the more regular rainfall.

28. AUSTRALIA: QUEENSLAND. *The Cotton Industry. Taking Stock.* (Abstr. from *Queens. Agr. Jnl.*, xxviii., 3, 1927, p. 228.) Mr. Forgan Smith, the Acting Premier, informed the Press recently that the 1927 cotton crop has, generally speaking, been of high quality, the bulk of it having been classified in the long-staple grades, for which there is the best demand at the most favourable prices.

The prospects ahead of the cotton industry are at the present time bright, and such as to afford encouragement to cotton-growers to increase their area. The demand for seed for the coming planting is very satisfactory, but it is essential that the land be well prepared, and looked after during growing operations. The officers of the Agricultural Department are available at all times to give advice to intending cultivators.

29. *Cotton Prospects.* (Abstr. from *Dalgety's Ann. Wool Rev. for Australasia*, 1926-27, p. 61.) A recent general survey of the cotton districts made by officers of the cotton section of the State Agricultural Department has shown that a marked feeling of optimism prevails amongst the cotton farmers with respect to the future prospects of the industry. In nearly all the districts the growers are contemplating planting larger areas during the coming season (1927-28), and, should good seasonal conditions be met with, the harvest should compare more than favourably with any of those of preceding years.

30. WEST INDIES: MONTSERRAT. (*Rpt. on the Agr. Dpt.*, 1924-25 *and* 1925-26, recently received.) *Cotton Cultivation.* The 1924-25 cotton crop occupied the greatest area since the inception of the industry, but unfortunately, just at the time when cotton-picking was becoming general, the hurricane of August 28 destroyed 60 per cent. of the crop. The area planted in 1925-26 was less than in the previous season, as the peasants were occupied in repairing storm damage and consequently could not devote much time to cotton-planting; estates, however, cultivated practically their usual areas.

Cotton-breeding experiments with Heaton 23-2-13, are described on pp. 3-8, and the investigation work on the pink bollworm on pp. 9-11. It is estimated that a loss of 25 per cent. is caused to the cotton industry during the season by this pest.

31. *Sea Island Cotton Cultivation.* In a letter to the *West India Comm. Circ.* of September 22, 1927, Mr. John Bromley of St. Kitts suggests that no Sea Island cotton should be grown in the Islands for a year, to allow of the consumption of the carry-over at present existing, and also to establish a sounder market for the cotton, and to exterminate, if possible, the pink bollworm, whose ravages have caused so much loss during recent seasons.

32. ST. VINCENT. *The Cotton Industry.* (Abstr. from the *Rpt. on the Agr. Dpt.*, 1926, recently received.) During the early months of the 1926-27 cotton season the crop looked more promising than it had looked at that period for many years. Much care had been taken in the cultivation and preparation of the soil, and more organic manure had been put in the land than had been the practice for some considerable time. Everything pointed to a record crop, but unfortunately the season, which opened so auspiciously, met with disaster, caused by the repeated attacks of cotton caterpillars. This would not have occurred had control measures been applied as soon as the insects were noticed in the fields. The peasant cultivators were in some cases willing to dust with arsenicals, but had not the money to purchase them. The most popular insecticide used in the West Indies for the control of cotton caterpillars is Paris Green, but it is probable that calcium arsenate, which is cheaper, will be the most extensively used insecticide in the future.

33. SEED SUPPLY IN ST. VINCENT. (Abstr. from the *Rpt. of the Agr. Dpt.*, 1926.) In the section of the Report dealing with the seed supply, the Colony is stated to have been particularly fortunate in that it has had an Empire Cotton Growing Corporation research officer (Mr. L. H. Burd) stationed in it for some years.

Such an officer has laid a foundation on which to build a fabric which places the cotton industry not only in a position of dominance but also one of soundness. One result of his work has been the development of several pure strains of cotton of which the Agricultural Department possesses data from the sowing of the seed right up to the final production of yarn. From two of these strains the supply of seed is obtained for general planting purposes. B.D. is used for general planting, and V.135 for growing extra superfine cotton. B.D. is a good yielder, with small percentage of flower shedding, high weight of lint per boll, and 28 per cent. ginning outturn, with maximum lint length of 51 mm. (just over 2 inches). V. 135 is very long (57 mm.) and fine, obtaining the very highest prices, but has a rather high percentage of flower shedding and a small amount of lint per boll. The seed of these varieties has been multiplied, and there is now enough B.D. for any local demand. V.135 seed is to be distributed somewhat upon the lines recommended by Balls in this Review (vol. iii., p. 331).

## *COTTON IN EGYPT.*

**34.** We have received from the Dpt. of Overseas Trade a copy of the *Rpt. on the Econ. and Financ. Situation of Egypt,* dated May, 1927, by E. Homan Mulock. An account is given on p. 10 of the financial assistance rendered by the Egyptian Government to the fellaheen and to the cotton industry at large. A résumé of the work of the Cotton Congress is also included.

**35.** La Culture et le Commerce du Coton (en Egypte). By H. Lorin. (*Rev. Econ. Fr.,* xlviii., No. 1, 1926, pp. 42-59. Abstr. from *Coton et Culture Coton.,* i., 2, 1926, p. 142.) Describes the hindrances put in the way of progress by cultivators changing from one variety of cotton to another which they think will prove more profitable.

## *COTTON IN THE UNITED STATES.*

**36.** We have received from the Dept. of Overseas Trade a copy of the *Rpt. on Econ. Conditions in the U.S.,* May-June, 1927, by Sir J. Joyce Broderick and Capt. A. J. Pack.

**37.** Report on the 1927 Journey through the U.S.A. Cotton Belt. By A. S. Pearse. (Int. Federn. of Master Cotton Spinners' and Manufacturers' Association, Manchester.) Commencing with a criticism of the U.S. Government crop reports, in which he lays it down that it is humanly impossible to forecast with any accuracy, even in September, Mr. Pearse goes on to point out that many outside speculators now take a hand upon the cotton market, and says that if the Government reports began only with October, speculation would not be so much encouraged.

Cotton Exchanges and Futures Contracts are then dealt with, and the author goes on to the recrudescence of the boll weevil, saying, *inter alia*: "Many had thought at the commencement of the season that the boll weevil would practically disappear, as during the last two years there had been almost an apparent immunity from boll-weevil damage, and when I pointed out in my previous report in 1925 that this abatement was only temporary, several cotton merchants and spinners took a decidedly different view; unfortunately, this year this little insect has reappeared and caused considerable damage to the crop." In Central Texas the weevil infestation was especially heavy.

The opening of the new port at Corpus Christi is described, and a good deal of information is given about sledding, mechanical picking, seed-breeding farms, the effects of the Mississippi floods, co-operation, etc. The report is furnished with several excellent illustrations.

38. UNITED STATES CONFERENCE OF COTTON-GROWERS. (*Cotton*, November 5, 1927.) Advices dated Charlotte, N.C., October 24, state that the American Cotton Association has issued a call for a Southwide cotton conference of cotton-growers and business interests to be held in Orleans on January 11 and 12. Below are the topics scheduled for discussion:

1. Creation of permanent financial machinery for retiring and holding any large surplus of cotton under ownership of growers until required for consumption.
2. Efficient control of cotton acreage, reducing the acreage in 1928.
3. Farm relief by Southern co-operative effort, instead of through legislative enactment at Washington.

39. AMERICAN COTTON. ANNUAL REVIEW. (*Man. Guard. Coml.*, August 25, 1927.) The usual valuable review of the cotton trade of America. Among other useful articles may be mentioned the following: "A Review of the 1926-27 Season: Smaller Crop and Larger Expected Consumption." by W. G. Reed; "Prospects of the New Crop: Favourable Early Conditions marred by Weather and Flood," by C. T. Revere; "The Grade of the Crop," by G. W. Fooshe; "The Effect of Low Cotton Prices," by M. R. Cooper, describing the different cultivation methods used in the eastern and western sections of the Cotton Belt, and also the different harvesting methods employed; "Effect of Price Changes on Acreage," by J. A. Becker; "American Consumption of Low Grades," by A. H. Garside; "A New Method of Harvesting," by V. H. Schoffelmayer, dealing with the 'Sledding' method; "New Uses for Cotton," by W. D. Hines.

40. AMERICAN COTTON TEXTILE INSTITUTE. (Abstr. from *Text. Rec.*, xlv., 536, 1927, p. 40.) After a year's work the Cotton Textile Institute of the United States can point to some satisfactory work. Its accomplishments are stated to be:

1. It has effected, for the first time in the history of textile manufacturing in this country, an authoritative organization representing the entire industry.
2. It has created a new spirit of co-operative effort among individual textile manufacturers.
3. It has put into operation three important and practical measures for developing the growth of the industry.

The most important section is probably that which devotes itself to discovering new uses for cotton fabrics.

41. PRACTICAL RESEARCH. (Extracted from *Text. Rec.*, xlv., 533, 1927, p. 38.) An American mill—the Pacific to be precise—one day appreciated the fact that when an end breaks in spinning or weaving productive operation ceases until the broken ends have been mended; elimination of breakages—or reduction of their number—was therefore sought. The experts set to work. They found that the breakage rate in the spinning-room was 46 ends per 1,000 spindles per loom. Causes were traced and remedies effected. The result was a lowering of the rate from 46 to 29, a reduction of 37 per cent. The percentage of breakage resulting from improper adjustment or functioning of the machinery was reduced to half its former rate, and more even yarn was produced. This is an example of definite practical research work within the mill.

42. COTTON EXPERIMENTS IN ARKANSAS. (Abstr. from the 38*th Ann. Rpt.*, 1926.) Breeding, varietal, and spacing experiments are described, also an experiment to determine the possibility of increasing the percentage of protein and oil in cotton seed.

43. **Sea Island and Meade Cotton in the South-Eastern States.** By O. F. Cook and C. B. Doyle. (*U.S. Dpt. Agr. Dirc.*, 414, 1927.) Calling attention to the various obstacles to the reintroduction of long-stapled cotton.

44. **Varieties of Cotton in North-West Texas.** By R. E. Karper and D. L. Jones. (*Texas Agr. Exp. Sta. Bull.*, 364, 1927.) From the summary we extract the following: (1) Cotton-growing has increased almost one hundredfold in the High Plains region in the past fifteen years, and has proved to be a dependable crop here at an altitude of 3,200 feet, with an average growing season of 207 days. (2) Cotton compares favourably with the sorghums as a drought-resistant crop adapted to dry-land farming, producing on the average ten pounds of lint to one bushel of grain sorghums. (3) A high pre-season rainfall is in general indicative of an average yield of cotton, and has almost as effective an influence on yield as does seasonal rainfall. (4) Conditions on the Plains favour cultivation of large areas per man, and harvesting the crop with cotton harvesters or sleds. (5) The early-maturing varieties have consistently given the highest yields. The Burnett has given the best yield, and while it has a small boll and lacks storm-resistance, it is a profitable cotton to grow under extreme conditions, because of its earliness. The medium to early strains of Mebane have given satisfactory yields, possess fair staple around one inch, and are storm-resistant. Under ordinary conditions, a good strain of Mebane cotton should be grown here. (6) Lightning Express, Acala, and Durango are early varieties of longer-staple cotton, which produce well, and can be profitably grown when a corresponding premium for the extra staple length is passed on to the producer.

45. **Large-Scale Cotton Production in Texas.** By L. P. Gabbard and F. R. Jones. (*Texas Agr. Exp. Sta. Bull.*, 362, 1927.) New developments have been made both in the growing and in the harvesting of cotton in the coastal plains region of Texas. They consist largely in the application of tractor power to cultivation; the " sledding " method of harvesting is also coming into considerable vogue. In this way the amount of labour required has been much reduced, so that larger areas may be cultivated by the same staff as previously attended to smaller areas. Analyses are included of the costs of production, hours of labour, etc.

46. **Cotton-Mill People of the Piedmont.** By Marjorie A. Potwin. (New York, Columbia University Press; London, P. S. King and Son, Ltd., price 12s.) An interesting sociological study of the cotton-mill district of South Carolina, which should prove of much interest to welfare workers in other similar districts.

## *COTTON IN FOREIGN COUNTRIES.*

47. **Argentina.** We have received from the Cotton Division, Ministry of Agriculture, Buenos Aires, a copy of each of the following pamphlets: No. 643, *El Mejoramiento del Algodon.* A Report presented at the First Cotton Congress, Argentina, held at Resistencia, in April, 1926. No. 677, *Memoria de la Division Algodonera, que incluye las campanas agricolas,* 1924-25 *y* 1925-26.

48. **Cotton Cultivation in the Republic.** (Abstr. from the *Rpt. of the General Manager, Central Argentine Rly.*, for the year ended June 30, 1927, p. 6.) The yield of cotton for the agricultural year 1926-27 is officially estimated at 42,000 metric tons, the following being the figures for the four previous years:

| | |
|---|---|
| 1922-23 .. .. .. .. .. | 19,434 tons. |
| 1923-24 .. .. .. .. .. | 43,860 „ |
| 1924-25 .. .. .. .. .. | 51,105 „ |
| 1925-26 .. .. .. .. .. | 97,400 „ |

The bulk of the cotton is derived from the Chaco Territory, but the scarcity of labour available during the short harvest-time constitutes a serious difficulty which hampers production.

49. COTTON IN BRAZIL. Wileman's *Brazilian Review*, in giving figures of areas under cotton, places the chief states in the following order for 1925-26: São Paulo (95,000 hectares), Parahyba (72), Pernambuco and Ceara (each 62), Maranhão (57), and Rio Grande do Norte (54).

50. CHINA. We have received through the Dept. of Overseas Trade a copy of the *Rpt. on the Coml. Industr. and Econ. Situation in China* to June 30, 1927, by H. H. Fox and H. J. Brett, together with a copy of the *Rpt. on the Trade of South Manchuria*, by O. White.

51. We have received from the Association Cotonnière Coloniale a copy of Bull. No. 80, containing much information regarding cotton cultivation in the French Colonies.

52. THE CZECHO-SLOVAKIAN COTTON TEXTILE INDUSTRY. (Abstr. from the *Text. Rec.*, xlv., 533, 1927, p. 45.) An article written by a well-known mill manager in Czecho-Slovakia dealing with the conditions existing, machinery employed, and methods adopted in the cotton textile industry of that country.

53. LE COTONNIER À LA CÔTE D'IVOIRE. By R. H. Lucky. (*Rev. de Bot. Appl. et d'Agr. Col.*, Bull. 57, 1926. Abstr. in *Coton et Culture Coton.*, i., 2, 1926, p. 156.)

54. LA CULTURE SÈCHE DU COTONNIER PAR LES INDIGÈNES EN AFRIQUE OCCIDENTALE FRANÇAISE. By H. Bloud. (Abstr. in *Coton et Culture Coton.*, i., 1, 1926, p. 69.)

55. LA QUESTION COTONNIÈRE DANS LES ÉTABLISSEMENTS FRANÇAIS DE L'OCÉANIE. By B. Raynaud. (*L'Océanie Française*, 92, 1926. Abstr. in *Coton et Culture Coton.*, i., 3, 1926, p. 206.)

56. SUR LA PRODUCTION DU COTON DANS NOS COLONIES, ET LES POSSIBILITIES D'AVENIR. By H. Hirsch, Administrateur-Directeur de la Cie de Culture Cotonnière du Niger. (*Bull. de la Réun. d'Études Algériennes*, xxix, 1927, p. 1.) Commencing with a warning against resting on the oars on account of the heavy American crop, M. Hirsch sets out to show that consumption is increasing so rapidly that there will be scarcity in ten years. The British Colonies are now producing about one-sixth of the consumption in England, while the French Colonies only produce one per cent. of the 1,250,000 bales consumed in France. The work of the Empire Cotton Growing Corporation and of the British Cotton Growing Association is described, and a good deal of the success is ascribed to the way in which the intermediary of the native chiefs has been employed, they being left with greater authority in British Colonies. A description is given of the methods followed in the Sudan, where the Sudan Plantations Syndicate also forms a factor in the work. M. Hirsch then points out that Belgium in the Congo has gone (proportionally) ahead of France, as she is now producing there one-fifth of the home consumption. After mentioning Italian work, he goes on to consider the conditions in the French Colonies, calling attention to various weak points in irrigation, seed supply, choice of best varieties, systems of administration of native affairs, etc.

57. TURKEY. We have received from the Dept. of Overseas Trade a copy of the *Rpt. on Economic and Commercial Conditions in Turkey*, dated May, 1927, by Col. H. Woods. Cotton is mentioned on p. 7.

## *COTTON: CULTIVATION AND MACHINERY.*

58. Irrigation in the Empire. By B. A. Keen. (Abstr. in *West India Comm. Circ.*, xlii., No. 753, p. 324; No. 754, p. 345.)

59. Tanganyika. Experiments with Cotton. (Abstr. from the *Rpt. of the Dpt. of Agr.*, 1926-27. Published by the Crown Agents, Millbank. Price 2s. 6d.) Accounts are given of the following: Time of sowing, distance of sowing, ratooning, and topping of cotton experiments, comparison of the Mp. selections with the ordinary district cotton, and an experiment on growing cotton with rice.

60. Soils of Tropical Africa. Soil Survey of British Tropical Possessions. By F. J. Martin. (*Trop. Agriculture*, iv., **9**, 1927, p. 165.)

61. Soil: Drying. By E. A. Fisher. (*J. Agr. Sci.*, 1927, **17**, 406-19. Abstr. in *Summ. of Curr. Lit.*, vii., **16**, 1927, C. 56.)

62. Soil Problems: Work in the Empire. (Extracted from the *Rpt. of the Rothamsted Experimental Station*, Harpenden, 1925-26, p. 36.) The water relationships of the soil, important as they are in British farming, are of supreme importance for great parts of the Empire where low rainfall compels recourse to irrigation for crop production. An increasing number of problems is being referred to Rothamsted from various regions of the Empire, and agricultural experts have been sent from India and Africa to study methods and problems in our laboratories.

The Empire Cotton Growing Corporation has made provision for a soil physicist to carry out investigations at Rothamsted. Dr. E. M. Crowther, who holds this post, last year studied some of the soil problems of the Gezira, the great irrigated area between the White and Blue Niles, for which purpose he worked in the laboratories at Wad Medani for the six months October, 1925, to March, 1926. He succeeded in tracing relationships between early rainfall and crop yields, and between permeability of the soil and its fertility, a rapid rate of movement of water being associated with a low salt content and high fertility. Some of the problems have been brought back to the Rothamsted Laboratories for further investigation.

63. Principles of Soil Microbiology. By S. A. Waksman. (Pubd. by Tindall and Cox, London, 1927. Abstr. from *Rev. Appl. Mycol.*, vi., **8**, 1927, p. 507.) This book is one of the most complete studies hitherto published on a branch of soil science which is steadily increasing in importance. A classified list of reference books of nine pages forms a useful feature of the work, in addition to the copious bibliography provided in footnotes.

64. Influence of Fertilizer Treatments on Stand or Germination of Cotton. By G. W. Musgrave and D. G. Coe. (*J. Amer. Soc. Agron.*, 19, 1927, **2**, pp. 171-180. Abstr. from *Exp. Sta. Rec.*, lvii., **3**, 1927, p. 229.) Experiments in North Carolina and Oklahoma were concerned with the effects on the stands of cotton of nitrogen salts at different rates and times of application, of potassium, and phosphorus, and of different methods of applying fertilizers. Applications made under the seed along the row, a method common in practice, inhibited the germination of cotton. The effect appeared to be more pronounced from nitrogen and potassium salts than from phosphorus. Such inhibition increased with increasing quantities of nitrogen from all sources, and was more marked with applications at planting than with those made before planting. Several methods of locating the fertilizer with reference to the seed gave results fully equal to the

unfertilized checks. Direct contact applications in concentrations of fertilizers immediately below the seed were found inferior. From the viewpoint of seed germination, application at the side of the seed row, within the cotton bed, and at about the seed level seemed especially worthy of consideration.

65. Effect of Fertilizers on the Fruiting Activities of Cotton Plants. By J. D. Warner. (*Jour. Amer. Soc. Agron.*, 18, 1926. Abstr. from *Exp. Sta. Rec.*, lvii., 2, 1927, p. 129.) Fruiting studies made in connection with fertilizer experiments at the South Carolina Pee Dee Substation showed that cotton on plats receiving nitrogen and potassium without phosphorus fruited slowly during the first part of the season, and reached the peak late. Phosphorus and potassium without nitrogen resulted in early season fruiting. While the fourth week was the most productive, there were only two weeks of rapid fruiting. Although phosphorus and nitrogen used alone stimulated early season fruiting, the period of rapid fruiting appeared to be comparatively restricted through the omission of potassium. A plat receiving a complete (8-4-4) fertilizer at the acre rate of 1,000 lb. fruited early in the season, and covered three weeks of rapid fruiting, indicating that the plant food was well balanced.

66. Effect of Fertilizers on the Germination of Seeds. By J. L. Maxton. (*Soil Sci.*, 23, 1927, 335-340. Abstr. from *Jour. of Text. Inst.*, xviii., 9, 1927, A. 287.) Under the conditions of this experiment, and with the fertilizers and seeds used, the following statements seem warranted: (1) The mixing of seeds and dry fertilizers together for one to four weeks does not injure the seeds to any noticeable extent. (2) The injury to germination, which occurs, takes place after the seeds are placed in moist soil, and not before seeding. (3) Some fertilizers cause greater reduction in germination than others. (4) Some seeds show greater reduction in germination than others because of contact with fertilizers in the soil. (5) The injury from the fertilizers seems to be to the seed, preventing germination rather than destroying the seedling before it appears above the surface of the soil.

67. Soil and Fertilizer Studies at the Georgia Station. (*Ga. Sta. Rpt.*, 1926. Abstr. from *Exp. Sta. Rec.*, lvii., 3, 1927, p. 212.) The progress of potash studies with cotton plants grown under controlled and comparative conditions is reported, and experiments on the relative availability of the phosphorus of dicalcium and tricalcium phosphate, of tricalcium phosphate with calcium carbonate, of aluminium phosphate, of iron phosphate with calcium carbonate, and of monocalcium phosphate, are described. When large amounts of the iron phosphate were present in the pots, the cotton plants were killed. Cotton plants did not grow with the usual water-soluble nutrients and ferric sulphate unless large amounts of tricalcium phosphate were present. A comparison of Florida soft rock phosphate, Tennessee brown rock phosphate, and Tennessee blue rock phosphate showed the first two to give about the same growth, whereas the Tennessee blue phosphate was inferior to both the others.

68. Results from Fertilizer Experiments with Cotton on Alabama Soils. By J. T. Williamson. (*Jour. Amer. Soc. Agron.*, 18, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., 9, 1927, p. 827.) The average of numerous experiments by the Alabama Experiment Station showed that a complete fertilizer gives best results with cotton on nearly all Alabama soils. Recent tests on rate and ratio of applying fertilizer to cotton made on Norfolk, Orangeburg, Dekalb, and Decatur soils showed that the proper rates for combining materials for cotton is sodium nitrate 100 lb., acid phosphate 200 lb., and potassium chloride 25 lb. Combined in the above ratio, the average profit from the use of 650 lb. per acre surpassed that from rates of 325 and 975 lb.

69. Field Crop Investigations in Georgia, 1926. (*Ga. Sta. Rpt.*, 1926. Abstr. from *Exp. Sta. Rec.*, lvii., 3, 1927, p. 225.) Except for weed removal, cultivation did not appear to benefit cotton. Close 4 to 8 inch spacing resulted in maximum yields. Seed cotton yields rose with an increase in the quantity of sodium nitrate applied. Top-dressing of sodium nitrate at planting or chopping did not differ much in results, while application at squaring was followed by an acre loss of 150 lb. of seed cotton. Comparisons were also made of nitrogen sources and home-mixed *v.* factory-mixed fertilizers for cotton.

70. Making Cotton Cheaper: Fertilizer Experiments 1921-26, Delta Branch Station. (*Miss. Sta. Circ.*, 71, 1927. Abstr. from *Exp. Sta. Rec.* lvii., 3, 1927, p. 229.) A continuation of fertilizer experiments with cotton showed that ammonium sulphate and sodium nitrate were similar in effectiveness. Cotton-seed meal, if as cheap per pound of nitrogen, seemed as economical as other nitrogen sources. From 150 to 200 lb. of sodium nitrate, or its equivalent in ammonium sulphate, is indicated for average Delta soils, all of the fertilizer to be applied at or before planting (*cf.* Abstr. 223, vol. iv., Empire Cotton Growing Review). Several commercial nitrogenous fertilizers have given good results during two years. Increases in the second cotton crop following soy beans in corn amounted to 13 per cent. in 1926.

71. Cotton Spacing Experiments at Greenville, Texas. By H. C. McNamara. (*U.S. Dpt. Agr. Bull.* 1473 [1927]. Abstr. from *Exp. Sta. Rec.*, lvii., 2, 1927, p. 129.) Spacing experiments during the period 1921-1925, inclusive, with Lone Star cotton, largely on Houston clay, and grown under rather dry seasonal conditions, gave results showing the larger yields from the closer spacings. Unthinned plants, 2 to 4 inches apart and 6-inch spacing, generally outyielded 12-inch spacing. Where hills were more than 1 foot apart, several stalks per hill made more cotton than one stalk per hill. Chopping seemed more likely to reduce than to increase yields. Close spacing gave indications of being more advantageous on light soils—*e.g.*, fine sandy loam—than on heavy soil, such as the black land. Close spacing reduces the size of plant, permits more stalk in the row without crowding, and promotes the setting of early bolls. Percentage and length of lint did not seem to be affected by close spacing, although the size of bolls was slightly reduced. The greater exposure of the land to sunlight, and the fact that closely spaced plants can be poisoned more effectively, may be of help in boll-weevil control.

72. A Contribution to the Character of the 1926 Cotton Season. (In Russian). By J. D. Nagibin. (*Trans. of the Turkestan Plant-Breeding Sta., Tashkent*, No. 11, 1927.) The author states that in Central Asia the following methods of cultivation are practised: (*a*) In regions with plenty of irrigation water, and possessing slightly alkaline soils, cotton is sown on ridges, and about three waterings are given before blooming. (*b*) In regions with a water shortage, possessing alkali soils and a level surface, cotton is sown broadcast, and only one watering is given before blooming.

73. Uniform Depth Press-Wheel Cotton-Planter Attachment. By W. B. Camp and J. S. Townsend. (*Dpt. Circ.*, No. 381, 1926, Washington. Abstr. in *Coton et Culture Cotonnière*, ii., 1, 1927, p. 35.)

74. Cotton Varieties for South-East Missouri. By B. M. King. (*Missouri Sta. Bull.*, 249, 1927. Abstr. in *Exp. Sta. Rec.*, lvii., 3, 1927, p. 229.)

75. Field Crops Investigations in Missouri, 1925-26. By W. C. Etheridge *et al.* (*Miss. Sta. Bull.*, 244, 1926. Abstr. from *Exp. Sta. Rec.*, lvii., 5, 1927, p. 424.)

Trice and Delfos cottons gave the best yields on the heavy or very fertile soils of the south-east Missouri lowlands, while Express and Acala led on the lighter soils. Express and Trice yielded the most seed cotton on Ozark upland soils and at the station. Plants (2 to 4) in hills 10 to 12 inches apart averaged 229 and 327 lb. more seed cotton, respectively, than single plants 12 and 18 inches apart. Fertilizer tests in several localities are commented on.

76. L'OPPORTUNITÉ DU DÉVELOPMENT DE LA PRODUCTION COTONNIÈRE. By M. Etesse. (*L'Agron. Col.*, No. 98, 1926. Abstr. from *Coton et Culture Coton.*, i., **2**, 1926, p. 141.) Deals with the cultivation of rotation crops, the keeping of the necessary stock, etc.

77. FIELD CROP EXPERIMENTS AT THE SOUTH MISSISSIPPI SUBSTATION. By E. B. Ferris and W. S. Anderson. (*Miss. Sta. Bull.*, 238, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **8**, 1927, p. 731.) Acre yields of seed cotton obtained after peas averaged 1,205 lb., soy beans 1,125, velvet beans 1,170, corn 1,015, corn and peas 1,190, corn and soy beans 1,185, and corn and velvet beans 1,195 lb.

78. COTTON: COST OF PRODUCTION. (Abstr. from *Trop. Agriculture*, iv., **9**, 1927, p. 168.) An extract from an article in the *African World*, dealing with the costs of producing cotton in Queensland, Uganda, and South Africa.

79. SLEDDED AND SNAPPED COTTON. By R. W. Philip. (*Cotton*, 91, 1927, **9**, pp. 867-70. Abstr. from *Exp. Sta. Rec.*, lvii., **5**, 1927, p. 493.) The relative merits of cotton harvested by snapping and sledding practices current in certain sections of Texas and Oklahoma are discussed from the viewpoint of the cotton mill.

80. COTTON SLEDDING. By R. W. Philip. (*Cotton*, **91**, 1927, 867-70. Abstr. in *Summ. of Curr. Lit.*, vii., **16**, 1927, E. 51.)

81. SAW GINS: EFFECT ON COTTON. By W. S. Federoff. (*Bibliotheka Chlopkowogo Djela*, 1927, No. 6, 134-90. Abstr. from *Summ. of Curr. Lit.*, vii., **18**, 1927, E. 58.) An investigation of the effect of different procedures on the ginned cotton is reported. For a constant number of revolutions of the saw, production and power consumption vary linearly with the density of the feed, but at high densities increased production is obtained at the expense of quality; there is no essential difference in the quality of the cotton between low and medium density feeding. With modern ginning equipment, the quantity of foreign substances, such as leaf, dust, and sand, and of motes (seed-coat fragments, etc.), decreases considerably, but neps increase, especially with high-density feeding. The strength of the cotton hair in no way depends on the ginning process. The amount of waste in modern ginning amounts to 1½ to 3 per cent., but as this loss is due largely to the removal of short fibre, it is balanced by improvement in the quality of the cotton. The prejudice against excessive speed is without foundation; a high speed (500-700 r.p.m.) and low-density feeding damages the cotton less than a speed of 250-300 r.p.m. and high-density feeding.

82. DETERIORATION OF COTTON DURING DAMP STORAGE. By A. C. Burns. (*Tech. and Sci. Serv. Bull.*, No. 71, Min. of Agr. Egypt, 1927.) To counteract the injurious effect caused by damp and dirty conditions of storage on the quality of seed cotton, the author suggests the following remedial measures: More care should be taken to avoid contaminating the seed cotton and lint with dirt and dust, and the cleaning operation should be more thorough. Storage periods should be curtailed, when possible, where there is any possibility of damp conditions prevailing; and where "heating of the seed" is noticed, such batches should be removed, opened up, and sun-dried. The sun-drying of seed cotton,

and its subsequent careful storage, should be advocated, with further sun-drying where dampness reveals itself, and more attention should be given to thorough ventilation. Sun-drying, prior to ginning, might well be recognized, though it is realized that the ginneries could hardly cope with such additional work. Large-scale "dry" baling should be given a fair trial.

In Parts I. and II. of the Bulletin experiments on the causes of deterioration are described, bacteria being the chief agent responsible. The results of spinning tests conducted by the Fine Cotton Spinners' and Doublers' Association, Manchester, on cotton which had been stored under good, normal, and very damp conditions, are also included.

**83.** RAW COTTON FAULTS: DESCRIPTION. (*Bibliotheka Chlopkowogo Djela*, 1927, No. 6, 112-33. Abstr. from *Summ. of Curr. Lit.*, vii., **18**, 1927, F. 27.) The defects occurring in raw cotton have been investigated and classified. The distribution of defects in samples of cotton and of waste, taken at various stages of the manufacturing process from the raw material to the finished card sliver, has been determined, and is shown in extensive tables. Neps and motes are the most dangerous impurities for the spinning process, since only these are found in the card sliver and can get through to the roving.

(Also *cf.* **2**, **20**, **39**.)

## *COTTON: DISEASES, PESTS, AND INJURIES.*

**84.** INSECTICIDES: THEIR ACTION AND CONSTITUTION. By H. H. Croucher. (*Trop. Agriculturist*, iv., **10**, 1927, p. 183.)

**85.** STUDIES ON CONTACT INSECTICIDES. PT. V. THE TOXICITY OF THE AMINES AND *N*-HETEROCYCLIC COMPOUNDS TO APHIS RUMICIS L. By F. Tattersfield and C. T. Gimingham. (*Ann. Appl. Biol.*, xiv., **2**, 1927, p. 217.) PT. VI. THE INSECTICIDAL ACTION OF THE FATTY ACIDS, THEIR METHYL ESTERS AND SODIUM AND AMMONIUM SALT. By F. Tattersfield and C. T. Gimingham. (*Ann. Appl. Biol.*, xiv., **3**, 1927, p. 331.)

**86.** NOTE ON THE NATURAL OCCURRENCE OF MAJOR PESTS OF COTTON IN RELATION TO CLIMATIC FACTORS. By F. M. Grillo. (*Proc. S. and E. Afr. Agr. Conf.*, 1926, Nairobi, pp. 179-180.)

**87.** PESTS OF COTTON. PART I. (In Russian.) By Z. S. Rodionov. (Abstr. from *Rev. Appl. Ent.*, xv., **9**, 1927, p. 474.) In view of the serious losses caused by insect pests to cotton in Azerbaijan, the Experimental Entomological Station, inaugurated in the spring of 1926, has undertaken a study of the insects occurring in these fields. The Orthoptera and Lepidoptera are here dealt with, their bionomics and possible remedial measures being discussed.

**88.** UEBER BAUMWOLLSCHÄDLINGE UND IHRE BEKÄMPFUNG. By P. Koenig. (*Zeitschr. Pflanzenkrankh.*, xxxvii., **7-8**, 1927. Abstr. from *Rev. Appl. Ent.*, xv., **9**, 1927, p. 480.) This is a list of the insect pests of cotton in the United States and Egypt, with brief notes on the injury they do and their control.

**89.** LES ENNEMIS DES CULTURES COLONIALES. By P. Vayssière. (*Actes et C.R. Assoc. Colon. Sci.*, iii., **23**, pp. 100-110 (in) *Rev. Appl. et Agric. Colon.*, vii., **69**, Paris, May, 1927. Abstr. from *Rev. Appl. Ent.*, xv., **10**, 1927, p. 519.) The author states that in view of the importance of developing cotton culture in the colonies, every effort must be made to keep down the insect enemies of that crop, and to avoid the introduction of any new pest. A list of cotton pests in each region should be drawn up, and the exact status of each determined by a thorough biological investigation. It is, above all, essential to appoint both entomological and pathological experts, and a plan should be outlined for dealing with the insect pests occurring in the colonies in the most economical way possible. Of all precautions, that of inspection of imports on arrival seems to afford the greatest measure of security. The organization of an autonomous service for the protection of colonial produce, under the administration of a central office in Paris, is outlined, and the necessary staff and expenditure are discussed. The legislation that has already been passed with a view to suppressing insect pests in the French Colonies is briefly reviewed, but much remains to be done in this respect, and the legislation should be made uniform throughout.

**90.** COTTON PESTS. By D. Milne. (*Rpt. Dpt. Agr. Punjab*, 1925-26, 1. Abstr. from *Rev. Appl. Ent.*, xv., 9, 1927, p. 489.) A new species of Earias was found feeding on wild plants of the genus *Corchorus*. Life-history studies showed that *Sida cordifolia* and hollyhock are alternate food plants of the spotted bollworms (*Earias insulana*, Boisd., and *Earias fabia*, Stoll.), and that the latter, under field conditions, appears to prefer *Hibiscus esculentus* to cotton. The pink bollworm (*Platyedra gossypiella*, Saund.) has been found to be a far more important pest in the extreme south-east of the Province than elsewhere. The Indian Central Cotton Committee is contributing £1,100 a year to the Punjab Government for a detailed study of this pest. An examination of cotton sticks from thirty-two districts showed that the attack of the cotton borer (*Sphenoptera gossypii*, Kerr) was stronger on desi than on American cottons. Studies are being made of *Myllocerus undecimpustulatus* var. *maculosus*, Desbr. (cotton white weevil).

**91.** WORK IN CONNECTION WITH INSECT AND FUNGUS PESTS AND THEIR CONTROL. By F. R. Shepherd and W. Howell. (*Rpt. Agr. Dpt.*, St. Kitts-Nevis, 1925-26. Abstr. from *Rev. Appl. Ent.*, xv., 9, 1927, p. 494.) *Alabama argillacea*, Hb., was not so prevalent as in the previous year, and did no damage to the cotton plants, being controlled by insecticides. Pink bollworm, which generally appears about the middle of June, slightly infests the earlier pickings of cotton, but it is possible, with proper control measures, to obtain large crops before any appreciable loss is sustained. Thorough cleaning-up of the old cotton fields, the burning of the cotton and other food plants such as okra (*Hibiscus esculentus*), the inspection of all fields before planting new crops, and almost simultaneous planting in all parts of the Island are necessary if this pest is to be kept under control.

In Nevis, damage was caused to cotton by the leaf-blister mite (*Eriophyes gossypii*, Banks), the cotton stainer (*Dysdercus andreæ*, L.), cotton aphis (*Aphis gossypii*, Glov.), pink bollworm, and *Alabama argillacea*, Hb. Bolls were shed to a greater extent than ever, over 30 per cent falling off in some cases.

**92.** THE BOLL WEEVIL: THE WORLD'S WORST INSECT. (*West India Comm. Circ.*, xlii., 754, 1927, p. 353.)

**93.** BOLL WEEVIL INVESTIGATIONS. By E. F. Grossman. (*Florida Sta. Rpt.*, 1926. Abstr. in *Exp. Sta. Rec.*, lvi., 9, 1927, p. 861.)

**94.** ACUERDO SOBRE LA REGLAMENTACION PARA EL COMBATE DEL "PICUDO" DEL ALGODON. (Abstr. from *Rev. Appl. Ent.*, xv., 10, 1927, p. 526.) Regulations for control work against the cotton boll weevil in Mexico.

**95.** NATURAL ENEMIES AND CONTROL OF BOLLWORMS IN SOUTH AFRICA. By G. C. Haines. (*Proc. S. and E. Afr. Agr. Conf.*, 1926, Nairobi, pp. 235-237.)

**96.** A NEW AND SERIOUS BOLL WORM; ARGYROPLOCE SP. By H. Hargreaves. (*Proc. South and East Afr. Agr. Conf.*, 1926, Nairobi, p. 171. Abstr. from *Rev. Appl. Ent.*, xv., 10, 1927, p. 562.) Larvæ of *Argyroploce leucotreta*, Meyr., were found infesting unripe maize cobs in Uganda in 1921, and subsequently they have been found infesting cotton bolls, within which pupation takes place. Although extensive damage by this moth has not been observed on cotton in Uganda, the author considers it to be a potentially serious pest. Doubt was expressed as to the identity of this moth.

97. TANGANYIKA: COTTON PESTS. (Abstr. from *Rpt. of the Dpt. of Agr.*, 1926-27, p. 30. Published by the Crown Agents for the Colonies, Millbank. Price 2s. 6d.) A further inspection of the Northern Tabora and Mwanza areas by the Entomologist has confirmed the opinion that the pink bollworm does not exist in this important cotton region. The non-cotton district to the east, west, and south, with the Lake on its north and north-western borders, will, it is believed, form a barrier, intended to be permanently maintained, against the spread of the pest into the region.

Experience has now proved that the enforcement of the legislative measures for the uprooting and burning of the crop, in time to allow a three months' dead season before the next sowings, is an effective means of combating the pink bollworm. The 1926 crop was remarkably free from the pest in those districts in which these measures had been actively enforced in 1924 and 1925. The Entomologist has reported that of 2,000 bolls examined, from districts in which the infestation towards the end of the 1924 season had risen to over 50 per cent., only two were found to contain the worm.

98. PRAGAS DO ALGODOEIRO. IV. LAGARTA ROSEA DOS CAPULHOS (Cotton Pests. IV. The Pink Bollworm). By L. A. de Azevedo Marques. (*Bull. Minis. Agr. Ind. e Comm.*, xvi., [1] 4, pp. 502-512, Rio de Janeiro, 1927. Abstr. from *Rev. Appl. Ent.*, xv., 9, 1927, p. 454.) This article describes methods of fumigating cotton-seed with carbon bisulphide and hydrocyanic acid gas against *Platyedra gossypiella*, Saund., which is now a serious pest of cotton in the north-eastern part of Brazil.

99. SOME NOTES ON CUTWORMS IN COTTON. By E. Ballard. (Abstr. from *Queens. Agr. Jnl.*, xxviii., 3, 1927, p. 229.) Deals with the history of the cutworm invasion at the Biloela Cotton Research Station, 1926-27, and the control measures advocated.

100. SUBSTITUTE FOR PRICKLY-PEAR IN CUTWORM BAIT. By L. B. Ripley. (*Farmg. in S. Afr.*, i., 6, 1926. Abstr. from *Rev. Appl. Ent.*, xv., 10, 1927, p. 522.) Experiments were carried out to discover suitable substitutes for prickly-pear in sodium fluoride cutworm baits. Certain plants with similar succulent tissue (*Cotyledon*, *Kalanchoe*, and *Mesembryanthemum*) proved suitable, and baits made with potato or pumpkin also gave satisfactory results, the pumpkin destroying a somewhat larger percentage of the caterpillars, probably owing to its greater power of absorbing the poison. Turnips, swedes, and mangels may be used as well as potato, but all these are liable to carry Nematodes and other infections not necessarily destroyed by the sodium fluoride, and the special cultivation of a small patch of spineless cactus is recommended in preference to incurring the risks connected with their use. Maize ensilage and similar substances are not readily eaten by the cutworms, and dry up too quickly.

101. ELIMINATING THE COTTON WORM. (Abstr. from *Text. Rec.*, xlv., 533, 1927, p. 94.) The Egyptian Ministry of Agriculture announces that the cotton worm has been virtually stamped out, owing to measures adopted in the affected area, which has been reduced from 90,000 to 5,000 acres.

**102.** THE COTTON LEAF CATERPILLAR (*Cosmophila erosa*). By J. C. Hutson. (*Leaflet* No. 47, *Dpt. of Agr. Ceylon*. Abstr. from *Trop. Agriculturist*, lxix., **3**, 1927, p. 166.) A brief account of the life history and habits of the insect, with recommendations for control. Several illustrations of the caterpillar are included.

**103.** THE INFLUENCE OF PARENTAGE, NUTRITION, TEMPERATURE, AND CROWDING ON WING PRODUCTION IN APHIS GOSSYPII, GLOVER. By H. J. Reinhard. (*Texas Sta. Bull.*, 353, 1927. Abstr. from *Exp. Sta. Rec.*, lvii., **4**, 1927, p. 360.) Following a review of literature, the author reports upon the effect of parentage, nutrition, temperature, and crowding, and observations on the effect of humidity on wing production in *A. gossypii*, Glover. He finds that the normal tendency in this aphid is to produce offspring which do not develop wings, the production of wings being dependent entirely upon environmental influences. Starvation increases the number of winged forms in the progeny produced by apterous parents. The offspring of alate parents revert to the normal tendency of the species—namely, the apterous form—with such puissance that the effect produced by starvation in stimulating wing development is practically, if not entirely, counteracted. Temperature within the limits of 70 to 90° F. does not affect the ratio of forms produced in this species. Crowding is a very potential, if not the dominant or controlling, factor in stimulating wing development in *A. gossypii*. There is no correlation between the prevailing relative humidity in which the aphids are reared and the ratio of alate to apterous forms produced.

**104.** COTTON APHIS (*Aphis gossypii*, Glover). By A. L. Hamner. (Abstr. from *39th Ann. Rpt. of Mississippi Agr. Exp. Sta.*, 1926, p. 18.) Gives details of dusting experiments to control cotton aphis.

**105.** CONSEJOS SENCILLOS PARA DESTRUIR LA LANGOSTA (Simple Instructions for Destroying Locusts). (Mexico: *Junta nac. Campana contra la Langosta*, Bol. Nos. 1, 2, 3, 1926. Abstr. from *Rev. Appl. Ent.*, xv., **10**, 1927, p. 526.) As a result of experiments, the following formula is recommended for a petroleum-soap emulsion in solid form that requires dissolving in water only at the rate of 1 lb. in 2 gals.: Coconut oil, tallow, caustic soda, 30 lb. each; wood-tar, flowers of sulphur, refined petroleum, 1 lb. each. The ingredients are mixed cold.

**106.** LA LUTTE CONTRE LES ACRIDIENS RAVAGEURS (MOROCCO). By P. R. Regnier. (*Dir. Gen. Agric. Comm. et Colon.*, Defense des Cultures, No. 2, Rabat, 1926. Abstr. from *Rev. Appl. Ent.*, xv., **10**, 1927, p. 520.) This paper is a comprehensive review of the measures available against locusts. Measures against the larvæ, to which most attention is devoted, include the use of insecticides in the form of sprays and baits, burning and crushing, and the use of barriers and traps, which are described in great detail.

**107.** LOCUSTS IN CENTRAL ASIA. By B. P. Uvarov. (In Russian.) (Abstr. in *Rev. Appl. Ent.*, xv., **10**, 1927, p. 513.)

**108.** THE BIOLOGY OF THYSANOPTERA WITH REFERENCE TO THE COTTON PLANT. I. THE RELATION BETWEEN DEGREE OF INFESTATION AND WATER SUPPLIED. By R. A. Wardle. II. THE RELATION BETWEEN TEMPERATURE AND LIFE CYCLE IN A SATURATED ATMOSPHERE. By E. I. MacGill. III. THE RELATION BETWEEN FEEDING HABITS AND PLANT LESIONS, By R. A. Wardle and R. Simpson. (*Ann. Appl. Biol.*, xiv., **4**, 1927, pp. 482, 501, 513.) Epidemic damage by Thysanoptera is often supposed to be connected with abnormal meteorological conditions, especially with low rainfall. These experiments seem to show some correlation. The second paper goes to show that the length of the life cycle is decreased by increase of temperature, the third that difference in injury is largely due to difference in thickness of the epidermis. Hairs on the leaf are no protection.

**109.** Joint Discussion of Sections K (Botany) and M (Agriculture) at the Leeds Meeting of the British Association upon the Control of Plant Diseases. (*Ann. Appl. Biol.*, xiv., 4, 1927, p. 544.) Mrs. Alcock spoke for the botanists, describing how the coming of the potato wart disease in 1902 awoke Great Britain to the need for control, and giving an account of the phytopathological service now at work. She pointed out that the margin of profit is small, so that methods must be certain, easy, cheap, and safe. To avoid disease is better than to control it. Dr. W. B. Brierley followed for agriculture with a general critical survey of the whole field, with special reference to research and to popularization of its results.

**110.** On the Relation of Soil Temperature to Angular Leafspot of Cotton. By R. E. Massey. (*Ann. Bot.*, vol. xli., No. 163, July, 1927.) The results of the experiments may be summarized as follows: Evidence has been obtained to show that the development of the bacterial disease of cotton caused by *P. malvacearum* in the seedling stage is confined to a definite range of soil temperature. At soil temperatures of 11-15° C. infection is slow, and in the case of lightly infected seed may be missed. From 16° C. to 20° C. infection is generally obtained, but, again, it is not usually serious if other environmental conditions are favourable for the growth of the seedling. From 21° C. to 26° C. infection is severe. Above 26° C. to 28° C. the infection again fades in intensity. Above 28° C. little or no infection is obtained. At 30° C. the plant is generally immune.

Experimental evidence suggests that the regional distribution of the disease caused by *P. malvacearum* may be explained on these grounds.

Some account has been given of the internal changes associated with varying temperatures, and indirect support is given to Faulwetter's work on the spread of the disease in the field by rain.

**111.** Plant Disease Studies at the New Mexico Station. (*New Mexico Sta. Rpt.*, 1926. Abstr. from *Exp. Sta. Rec.*, lvii., 3, 1927, p. 244.) Acid delinting tests for the control of anthracnose and bacterial boll rot (*Bacterium malvacearum*), as described with results from various concentrations, showed that, although with 66° B. acid delinting is usually complete in 10 to 15 minutes, seed can be left in such acid 20 to 24 hours, and, in fact, germination was sometimes increased in such cases.

**112.** Aspergillus Niger: Growth. By T. Sakamura. (*Japanese J. Bot.*, 3, 1927, 245-65. Abstr. from *Summ. of Curr. Lit.*, vii., 15, 1927, A. 28.) Continuing previous work, experiments are described which confirm the supposition that the added organic salts and phosphates, which increase the growth of the fungus, act primarily as buffer substances, and not as nutrient substances.

**113.** The Two Most Common Decays of Cotton Bolls in the South-Western States. By M. Shapovalov. (*J. of Agr. Res.*, 35, 4, 1927, p. 307.) Two forms of decay of cotton bolls, frequently referred to as "smut" in their later stages, have been found to occur commonly in South-Western United States. These diseases are not true smuts, and have only a superficial resemblance to the smuts. One of these forms of decay is caused by *Aspergillus niger*, Van Tiegh. and the other by *Rhizopus nigricans*, Ehr. The two diseases may be readily distinguished by the discoloration of the affected tissues, as well as by the character of the fruiting stages of the parasites. Both organisms readily produced rot of artificially wounded and inoculated cotton bolls, but failed to affect uninjured bolls. The infection in the field apparently depends on injuries caused by various insects, the most noticeable of which are those caused by the bollworm. Control measures, therefore, will have to be directed chiefly against these insect enemies.

**114. Studies in the Biological and Cultural Characters of Capnodium sp. on Cotton.** By K. Sawhney. (*Jour. Ind. Bot. Soc.*, v., 4, 1927, 141-186. Abstr. from *Rev. Appl. Mycol.*, vi., 9, 1927, p. 550.) This paper gives a detailed account of a species of Capnodium which in 1925 was found to cause brown specks on the under side of leaves and on the bolls of Sea Island, American, and Indian local (Desi) varieties of cotton grown in the Botanical Gardens of Lahore. On both organs the infection appeared to have originated in the nectar glands, which, in the bolls, are placed at the base of the calyx tube within the bracteoles, and alternating with the latter. On the leaves the infection is stated usually to start on the midrib, which is the first to develop a gland; later, the fungus spreads along the midrib from the gland, forming a long strip, and then to the neighbouring veins. The bolls are infected when they are well on their way to maturity. It is thought probable that the fungus finds a suitable nutrient medium for growth in the sugary exudation of the glands. Artificial inoculation experiments showed that other parts of the plant—*e.g.*, the stem and petioles—were capable of being infected with the fungus through wounds, when the inoculated parts were kept moist for some days; on parts of the stem left uncovered the inoculations failed.

Histological investigation showed that the hyphæ of the fungus come into close contact with the host only in the region of the glands; outside this region they form a sort of felting over the plant parts. The uppermost cells of the gland are the first to be attacked; the cytoplasm collects towards the centre of the cell in a grumous mass, which turns brown, probably owing to the oxidation of substances such as tannin, in the cells, and breaks up into amorphous granules. This process gradually extends to the lower cells, until finally nothing remains of the gland but a cavity with no walls, no protoplasmic contents, and only a number of dark, refractive globules scattered here and there. In severe cases the fungus was found to spread also to the neighbouring parts of the leaf, gradually killing the cells, and in some places even penetrating the host tissue to a considerable distance towards the vascular bundle.

The fungus, in the author's opinion, is dangerous in that it lowers the vitality of the host, and renders it susceptible to the attacks of other organisms. It also lowers the quality of the lint in the attacked bolls.

**115. Some Observations on the Oospores of Phytophthora Species.** By W. C. Lester-Smith. (Abstr. from *Ann. Roy. Bot. Gardens, Peradeniya, Ceylon*, x., 3, 1927, p. 243.) These observations were made during the tenure by the author of a Senior Studentship under the Empire Cotton Growing Corporation, at the Imperial College of Tropical Agriculture, Trinidad, 1924-25. *Summary*: (1) Three strains of *Phytophthora parasitica*, Dastur, have been grown in pure culture, and the mean size and range of the oospores determined.

(2) Three strains of *Phytophthora faberi*, Maublanc, have been grown in mixed cultures with each other, and the mean size and range of oospores produced have been recorded.

(3) The three *parasitica* strains have been grown in mixed culture with the three *faberi* strains, and the sizes of the oospores produced have been recorded.

(4) Evidence is obtained that each of the strains of *faberi* have developed oospores when grown in culture with homothallic *parasitica* strains.

(5) It appears probable that all strains of *faberi* can be induced to develop oospores under certain conditions.

(6) These findings present no support to the view that *P. faberi* is heterothallic; direct evidence of heterothallism in the genus *Phytophthora* has not yet been recorded.

(7) Mixed cultures of *parasitica* strains with *Phytophthora nicotianæ*, Br. de Haan, have developed oospores which indicate a mean size of 22·0 microns,

and a range of 18·0 to 25·0 microns for the oospores of *nicotianæ*; all the oospores seen in these cultures were distinctly of the amphigynous type.

(8) The theory is put forward that the development of oospores by strains or species of *Phytophthora* is due to the influence of environment on the rate of metabolism of the thallus.

**116.** RECENT WORK ON ROOT DISEASE OF ECONOMIC AND OTHER PLANTS IN CEYLON. By W. Small. (Abstr. from *Trop. Agriculturist*, lxviii., 4, 1927, p. 201.) Root diseases, hitherto supposed to be due to *Fomes*, *Ustulina*, etc., are common and destructive to tea, rubber, and other crops. Careful examination seems to show that these fungi are always accompanied by *Rhizoctonia bataticola*, which the author regards as the fundamental cause of root disease, a conclusion which, if borne out by further research, is obviously of great importance; it is, however, strenuously rejected by other mycologists.

**117.** COTTON ROOT ROT DISEASE. (*Texas Sta. Rpt.*, 1926. Abstr. from *Exp. Sta. Rec.*, lvii., 2, 1927, p. 149.) Studies have been continued on the cotton root rot disease, attention being particularly given to the destruction of the host by the organism. It was found that the effect is correlated with the time of the year when infection takes place. When young seedlings are infected early in July, they are said not to die immediately after the roots have become attacked, but they alternately wilt and revive for a period of from 4 to 10 weeks before the plant finally collapses. An effort was made to determine whether the fungus spreads other than by root contact, and it was found that the spread of the causal organism from one plant to another was not as rapid as formerly believed. The spread seems to be influenced by the age of the plant, and possibly by the concentration of the plant sap, and also by the season. An effort was made to determine the tolerance of the fungus to an alkaline or acid medium, and the studies seem to indicate that it may be possible to control root rot in some soils by changing their reaction either to a point of acidity below $pH_4$ or a point of alkalinity above $pH_9$.

**118.** A STUDY OF FUSARIA COMMON TO COTTON PLANTS AND COTTON SOILS IN THE CENTRAL PROVINCES. By Jiwan Singh. (Obtainable from the Govt. of India Cent. Pubn. Branch, Imperial Secretariat Building, 3, Government Place West, Calcutta. Price As. 5, or 6d.) The parasitism of all the strains of *Fusaria* so far isolated from various sources was tested by inoculation experiments during the cotton seasons of 1924-25, 1925-26, and 1926-27. Inoculations were done by heavily infecting the soil with vigorously growing cultures one or two weeks before sowing seed, or at the time of sowing seed, or when the plants were two to four weeks old. Some plants were inoculated once every fortnight for six months. None of the inoculated plants suffered from "wilt." From the inoculated soil the fungus used for the inoculation was re-isolated six months after the soil had been infected, showing thereby that the *Fusarium* remained viable in the soil, but was incapable of infecting plants sown in the inoculated soil.

**119.** A DISEASE OF COTTON ROOTS PRODUCED BY FUSARIUM MONILIFORME, SHELD. By N. C. Woodroof. (*Phytopath*, xvii., 4, 1927, pp. 227-238. Abstr. from *Rev. Appl. Mycol.*, vi., 10, 1927, p. 609.) A dwarfed condition of cotton plants, observed in the fields at the Georgia Experiment Station since 1920, was found to be due to *Fusarium moniliforme* (*Gibberella moniliformis*). The pathogenicity of this fungus was proved by successful inoculation of cotton seedlings in pot cultures and in field tests. The characteristic dark-brown lesions present on the roots and gradually girdling them are described. The fungus never penetrates deeply into the cortical cells, but the spread of the disease to the lateral roots, and the persistence of the mycelium on the primary root, where it causes a kind of dry rot, are responsible for the dwarfed condition. Experimental evidence showed that the infection is spread on the lint of cotton-seeds by air-borne spores and by the presence of the mycelium in the soil. The improbability of internal seed infection was shown experimentally, although a pink boll rot was found to be caused by the same organism.

The cultural characters of the fungus on a number of media are given, as well as reasons for its identification as *F. moniliforme*. Cultures of this species obtained from soil in Central America and from maize were also found to produce the above symptoms on cotton.

Disinfection of cotton-seed with a number of dusts was successful in producing clean seedlings when the latter were raised in a germinator, but as a means of control in the field this method was worthless, on account of the infestation of the soil with the causal organism. Further control tests are still in progress.

**120. Note sur la "Wilt Disease" en Égypte.** By R. H. Lucky. (Abstr. from *Coton et Culture Cotonnière*, ii., 1, 1927, p. 12.) A review of the subject by an inspector of the Royal Agricultural Society of Egypt.

## *COTTON: BREEDING, GENERAL BOTANY, ETC.*

**121. Plant Breeding: The "Pure Line" Concept.** By J. B. Hutchinson. (Abstr. *Trop. Agriculturist*, iv., 11, 1927, p. 206.) A clear statement of the conception of pure lines, which we owe to Johannsen (1903). The conclusions drawn are:

1. In selection work, propagating simply from the best individuals is not enough. Families should be grown from a series of individuals representative of the whole range of types found—good, bad, and indifferent. Unless there is a significant correlation between the intensity of expression of the character in the parent, and its intensity of expression in the offspring, it is no use carrying the selection any further. If considerations of time and space preclude growing families from a complete range of types, make one or two selections from undesirable types, and grow them beside the desirable selections. If the line is pure, there will be no significant difference between the two selections.

2. When a pure line is being carried on from year to year as a routine measure, rigorous annual selection is unnecessary, provided protection from outside contamination is assured; but a periodical analysis is desirable to guard against contamination by mutation.

**122. The Indigenous Cotton Types of Burma.** By T. D. Stock. (*Mems. Dpt. Agr. in India*, 1927, vol. xiv., 5.) A detailed and illustrated account.

**123. Korea. Cotton Plant: Boll-Shedding.** By S. Mihara and R. Yosinaga. (*Japanese J. Bot.*, 1927, 3, [57]. Abstr. from *Summ. of Curr. Lit.*, vii., 15, 1927, E. 44.) Shedding of young bolls is frequent, separation taking place at the junction of the stem of the boll and the bearing branch. The percentage of bolls shed varies with the variety from 42·2 to 68·9 per cent. The bolls are most liable to shedding at 4 to 6 days after flowering, and rarely fall when over a week old. Shedding is increased by rain and excessive soil moisture, also by artificial wounding.

**124. Primitive Cottons in Mexico.** By O. F. Cook and J. W. Hubbard. (*Journ. Hered.*, xvii., 12, 1926, pp. 462-72. Abstr. from *Exp. Sta., Rec.*, lvii., 3, 1927,

p. 230.) Five species of cotton plants described as new, and obtained in north-western Mexico, include *Gossypium morrilli*, *G. dicladum*, *G. hypadenum*, *G. patens*, and *G. contexium*. *G. davidsoni* was found in abundance near Guaymas, growing as a wild plant among other desert vegetation.

**125.** THE COTTON PLANT: BOTANICAL AND AGRONOMICAL SUMMARY. By G. S. Zaitzev. (In Russian only.)

**126.** LE COTON "ACHMOUNI MALAKI." (Abstr. from *La Rev. Agr. Égyptienne*, 1926, p. 72.) After some years of work the Botanical Section has obtained selected groups of Ashmouni, known as *A. Malaki*. Seed has been distributed to the cultivators of Upper Egypt under conditions safeguarding it from crossing with other types. The yield has reached 10 kantars a feddan.

**127.** TRANSACTIONS OF THE TURKESTAN PLANT-BREEDING STATION, TASHKENT, No. 4. By G. S. Zaitzev. A summary of the work carried out at the Turkestan Plant-Breeding Station during the year 1925. (In Russian.)

**128.** VICINISM OR NATURAL CROSSING IN COTTON. By H. B. Brown. (*Tech. Bull.*, No. 13, *Miss. Agr. Exp. Sta.*, 1927.) The literature on the subject is reviewed, and experiments in natural crossing are then described. The summary is as follows:

1. Cotton flowers are large and showy, and attract many insects.
2. A survey of the literature published on the subject shows that a limited amount of natural crossing takes place in all cotton-growing countries if different varieties are planted in close proximity. The crossing between alternate rows is usually 5 to 10 per cent.
3. In experiments made by the Mississippi Experiment Station, four different years, the natural crossing between adjoining rows ranged from 1·6 per cent. to 14·7 per cent., with an average of 6·2 per cent.
4. The amount of crossing depends on the time and rate of blooming of the neighbouring varieties and the number of insect visitors.
5. If the areas planted are large, the crossing extends to a greater distance, and is more frequent on the adjoining rows.
6. Individual green leaf plants grown at various points in a plat of red leaf cotton, where they were surrounded by many red leaf plants on all sides, had more than 50 per cent. of their seed crossed.
7. The New World and Egyptian species and varieties intercross freely, but they do not cross with the Old World cottons. The Old World cottons intercross.
8. A limited amount of crossing will take place at a distance of more than a hundred yards.
9. Natural crossing is harmful in unselected strains of cotton, but may be helpful to the cotton breeder.

**129.** ARTIFICIAL AND NATURAL ASIATIC-AMERICAN COTTON HYBRIDS. By G. S. Zaitzev. (*Agr. Jnl. of India*, vol. xxii., 1927, Pts. III. and IV., pp. 155-167 and 261-268.) The general conclusions deduced from the examination of the available data may be as follows: Although under some exceptional conditions we are able to obtain artificial and natural hybrids of *G. herbaceum*, L., with *G. hirsutum*, L., in view of their complete sterility they are useless.

**130.** ON THE FRUCTIFICATION IN INTER-SPECIES HYBRIDS OF COTTON. By G. S. Zaitzev. (*Trans. of the Turkestan Plant-Breeding Station, Tashkent*, No. 2.) This pamphlet is written in Russian, but includes a summary in English, which we quote as follows: "(1) When cross-breeding species of the cotton-plant which genetically are far distant, as are on the one side the American forms (*G. hirsutum*, *G. barbadense*, etc.), and on the other the Asiatic forms (*G. herbaceum*, *G. obtusifolium*, etc.), it is necessary to bear in mind some mechanical obstacles disturbing the normal course of the processes, which condition the fructification. (2) One of the principal mechanical obstacles to fructification with the above-mentioned cross-breeding is the strongly delayed growth of the pollen-tube in the foreign tissue of the style, and the premature rupture of the latter, which inevitably takes place in almost every flower of the cotton-plant, and which is conditioned by the peculiar organization of this flower. (3) The artificial preventing of the rupture of the style which may be obtained (with castration) by the complete removal of the perianth (corolla and stamen-tube), laying open the whole pistil, will make it possible for the slow-growing foreign pollen-tubes to reach the ovules and fertilize them. (4) This removal of the mechanical obstacles, interfering with the fusion of the gametes, leads in a great number of cases of cross-breeding between species to the formation of hybrid germs, though characterized by weakness of their development. Together with these, almost normally, the whole fruit develops—the boll with its composing elements. (5) The weakness in the development of the hybrid germs, obtained by our experiment, may be attributed to a considerable extent to the weakness of the gametes (especially the male ones), for the experiment of cross-breeding has been performed in August, when the natural percentage of falling off of the bolls is usually very considerable, and in some cases reaches 100 per cent. (6) Under conditions more favourable for fructification at an earlier season, and with more extensive experiments, there is much probability of obtaining quite developed germs. (7) A more thorough understanding of the phenomena accompanying the fructification of the cotton-plant, and the understanding of the causes which hinder the normal development of the hybrid germs, will be possible by means only of corresponding histological and cytological investigations."

181. STUDIES IN GUJARAT COTTONS. PT. IV. HYBRIDS BETWEEN BROACH-DESHI AND GOGHARI VARIETIES OF G. HERBACEUM. By M. L. Patel and S. J. Patel. (*Mems. Dpt. of Agr., India*, 1927, vol. xiv., 4.) The object of the work reported in the present memoir was definitely the production of a type of cotton for the Surat and Broach districts, which, while retaining the staple and quality of the present fibre, should, at the same time, have a higher ginning outturn. This has been successfully accomplished in the case of a cotton suitable for Broach, and this is now being multiplied for distribution on a large scale. A similar result appears also to have been achieved in connection with cottons suitable for Surat, though it is not quite certain whether the spinning value of the typical high-class Surat cotton (1027 A. L. F.) has been retained.

Incidental to the above practical object, the data collected have been employed to study seven characters of the cotton-plants used as parents of two crosses between pure types of Broach-deshi (1027 A. L. F. and 1-A Cylindrical boll) and of Goghari (E-5) cottons, all being strains of *G. herbaceum*, and also the same characters in six generations of the resulting crosses. The main objects of the study were two, as follows:

1. To determine whether the characters studied are simple Mendelian characters which can be transferred without change from plant to plant, or are complexes of a number of factors which, while normally inherited together, may be separated in the course of inheritance.

2. To ascertain whether the several characters studied are genetically correlated—that is to say, whether there is coherence of these characters during inheritance.

The seven characters studied were:

Node in the stem from which the first sympodium arises,
Diameter of the bolls,
Shape of the boll,
Length of staple,
Weight of seed,
Lint index, or the weight of lint per 100 seeds,
Ginning percentage,

and an account is given of each.

132. PEDIGREE SEA ISLAND COTTON SEED. Professor Cheesman's Report and recommendations. (Abstr. from *West India Comm. Circ.*, xlii., 757, 1927, p. 401.) A criticism, with suggestions for improvement.

133. DEVELOPMENT OF FLOWERS AND BOLLS OF PIMA AND ACALA COTTON IN RELATION TO BRANCHING. By H. F. Loomis. (*U.S. Dpt. Agr. Bull.* 1365, 1927. Abstr. from *Exp. Sta. Rec.*, 57, 1, 1927, p. 35.) This investigation, which continued the study of fruiting parts of cotton made by Martin, Ballard, and Simpson, was carried on at Sacaton, Arizona, during 1924 and 1925.

More floral buds or squares were produced by the Acala plants in each season than by Pima plants. Acala shed a higher percentage of squares and developed a much smaller percentage of squares into bolls. The mean age of shedding after appearance of squares was slightly earlier in Pima than in Acala, but more Acala squares shed when well advanced in age, and the period of liability for a square to shed was longer in Acala. Among squares of the same date, those on outer nodes of fruiting branches of both varieties required longer to develop into flowers than those on inner nodes. The periods on all of the nodes lengthened as the season progressed. The mean square period for Pima was slightly over 33 days in both years, and for Acala the period was 28 in 1924 and 29 in 1925. On specific nodes of fruiting branches of both varieties the percentage of square-shedding increased, and the percentage of squares developing into bolls decreased toward the branch ends. Branches of one node only, both on main stalks and on vegetative limbs of both varieties, had a higher percentage of squares shed, and fewer squares developing to mature bolls than on node 1 of longer fruiting branches. The last, or outer node, of all fruiting branches of two or more nodes on main stalks and vegetative limbs of each variety shed a larger proportion of squares and developed fewer mature bolls. Boll-shedding from specific nodes increased appreciably in both types on the outer nodes of fruiting branches.

Pima and Acala squares were shed in shorter periods in the early part of the season than in the later. The position of a square on a fruiting branch of Pima did not materially hasten or retard the shedding of that square, whereas squares shed from the outer nodes of Acala branches were usually somewhat older than those which fell from inner nodes. The maturation period of bolls of the same flowering date was longer on outer than on inner nodes of fruiting branches of both varieties. Boll periods on all nodes lengthened as the season progressed, averaging about 58 days on Pima and 53 days on Acala in 1924, and about 62 and 57 respectively in 1925. The boll period on node 2 apparently was lengthened by the presence of a boll on node 1.

134. GROWTH OF FRUITING PARTS IN GOSSYPIUM CERNUUM, AN ASIATIC COTTON. By R. E. Beckett. (Abstr. from *Jour. of Agr. Res.*, vol. xxxv., No. 2, 1927, p. 97.) The Garo Hill cotton (*Gossypium cernuum*) is one of the Asiatic series which is very remote in plant characters from the Egyptian and Upland varieties grown in the United States, so that differences in habits of growth might be expected. Most of the Asiatic cottons are not adapted for cultivation in the

United States on account of their very small bolls, but the Garo Hill has the largest bolls of any Asiatic type, nearly as large as those of the Texas big-boll cottons, as represented in this comparison by the Lone Star variety.

The growth rates and sequence in development of the fruiting parts of the Garo Hill cotton were determined at Greenville, Texas, by the same methods that were used on the Egyptian and Upland types of cotton, and reported in previous publications.

The interval between the appearance of successive fruiting branches on the main stalk is somewhat shorter in the Garo Hill cotton than in the other types, while the interval between successive squares on the branches is somewhat longer. The shedding of abortive bolls in Garo Hill occurred more promptly within 3 to 5 days after flowering, while many abortive bolls of Lone Star were held for 6 to 8 days, and some from 9 to 11 days. The rate of growth of the buds and bolls was nearly the same in the Garo Hill cotton as in the other types. The maturation period of bolls of the Garo Hill was somewhat longer than that of Lone Star, though the difference was slight, and may not be significant.

In the latter part of the season, a lengthening of the maturation period of Garo Hill bolls was found, which also is in agreement with the behaviour of the Lone Star and Pima varieties. Garo Hill bolls which were set early in August had a period 10 to 12 days shorter than bolls set in September.

**135.** Some Morphological and Physiological Peculiarities of Cotton-Plant Seed and their Agricultural Importance. By F. M. Mauer. (*Trans. Turkestan Plant-Breeding Station, Tashkent*, No. 6, 1927.) From the summary, which is given in English, we abstract the following: " The biology of the cotton-seed is in an intimate manner connected with its morphology. Seed of various botanical forms of the cotton plant, and consequently of various agricultural varieties of it, are distinguished by a great morphological diversity, which is especially noticeable in the structure and degree of development of the seed coat. At the time of maturing and dehiscence of the bolls, the cotton-seed requires some additional time and a certain set of conditions for " complete ripening " and reaching the stage of fully matured seed available for planting purposes. The best depth for planting cotton-seed, under the conditions of Central Asia, is from 4·5 to 6·5 cm.; a shallower planting is dangerous, owing to the rapid drying of the soil surface, while deeper planting is injurious because of the exhaustion of the vitality of the young cotton plants.

**136.** Inheritance of Smooth Seeds in Cotton. By T. H. Kearney. (Abstr. from *J. of Agr. Res.*, vol. xxxv., 3, 1927, p. 193.) *Summary.*—It is desirable that the seeds of long-staple cottons which are ginned on the roller type of gin should be as free as possible from fuzz or short hairs. This makes smooth-seededness an important objective in breeding work. Knowledge of the manner of inheritance of smooth and fuzzy seeds will therefore be useful to cotton-breeders. This paper presents the evidence, from crosses between smooth-seeded and fuzzy-seeded cottons, that the inheritance of this character is mainly of a simple Mendelian type.

Crosses were made between representatives of a family of Pima Egyptian cotton homozygous for very little fuzz on the seeds, designated the smooth-seeded Pima family, and representatives of a family homozygous for the much more fuzzy condition of the seed coat typical of the same variety. $F_1$ was uniformly smooth seeded, and the segregation in $F_2$ was in the ratio 3 smooth to 1 fuzzy. The smooth-seeded and the fuzzy-seeded segregates closely resembled the respective parents. Third-generation progenies were grown from self-pollinated seed of 20 smooth-seeded and of 10 fuzzy-seeded $F_2$ plants. The progenies of fuzzy-seeded $F_2$'s were uniformly fuzzy seeded. Of the smooth-seeded $F_2$ plants, two were probably homozygous, their $F_3$ progenies having contained no fuzzy-seeded plants. The remaining 18 progenies showed segregation in various proportions, but when taken as one array, 24·6 per cent. of the population were fuzzy seeded, and the departure from the expectation (25 per cent.) was only one-fourth its probable error. The evidence justifies the conclusion that in the Pima variety the fuzzy condition is recessive to the smooth condition.

The same and other smooth-seeded and fuzzy-seeded families also were used in another series of combinations. Some of these were hybrids between very different species of Gossypium, Egyptian cotton (*G. barbadense*, × ?) and Upland cotton (*G. hirsutum*). The hybrid populations of these combinations were small, and the results obtained are to be regarded as suggesting rather than proving the nature of the inheritance. Of the families which furnished the parents of these combinations, the smooth-seeded family of Upland cotton had the seeds almost entirely devoid of fuzz, hence much smoother than in the smooth-seeded family of Egyptian (Pima) cotton. The fuzzy-seeded families of Upland cotton, on the other hand, had much fuzzier seeds than the fuzzy-seeded families of Egyptian (Pima) cotton. Crosses (combinations 1 and 2) between the smooth-seeded Egyptian (Pima) family used in the first series of combinations and another fuzzy-seeded Egyptian (Pima) family, not related to the family used in the first series, showed similar dominance of smooth-seededness and monohybrid segregation in $F_2$. The results of a cross between two plants of Upland cotton, one phenotypically smooth seeded and probably homozygous, the other homozygous for fuzzy seeds (combination 3), indicated that in Upland cotton also there is dominance of the smooth condition and monohybrid segregation in $F_2$. Crosses between fuzzy-seeded Egyptian (Pima) and fuzzy-seeded Upland families (combinations 4, 5, and 6) produced only fuzzy-seeded plants in $F_1$, and, almost certainly, only fuzzy-seeded plants in $F_2$, the results indicating that all of these families were homozygous. A cross between a homozygous smooth-seeded Egyptian (Pima) plant and a phenotypically smooth-seeded Upland plant (combination 7) gave a uniformly smooth-seeded $F_1$ and a near approach to a 3 (smooth) to 1 (fuzzy) ratio in $F_2$. The occurrence in $F_2$ of fuzzy-seeded segregates, which resembled Upland cotton in the quantity and character of the fuzz, suggests that the individual of the smooth-seeded Upland family which served as one of the parents of this cross was heterozygous.

A cross between a homozygous fuzzy-seeded Egyptian (Pima) plant and a phenotypically smooth-seeded Upland plant (combination 8) gave a uniformly smooth-seeded $F_1$ and segregation in $F_2$ in the proportion of 12 smooth to 9 fuzzy, which, because of the small size of the population, is probably not a significant departure from a 3:1 ratio. Although the absence of fuzzy seeds in $F_1$ indicates that the Upland parent was homozygous in respect to the major factor for smooth seeds, yet this plant may have carried an intensifier for fuzziness since the fuzzy-seeded segregates in $F_2$ had the Upland degree of fuzziness.

A cross between a homozygous smooth-seeded Egyptian (Pima) plant and a homozygous fuzzy-seeded Upland plant (combination 9) gave only fuzzy-seeded plants in $F_1$ and segregation in $F_2$ in approximately the ratio of 1 smooth to 3 fuzzy. In both hybrid generations there was considerably greater variation in the quantity and character of the fuzz than was the case with the other combinations. The behaviour of combination 9 indicates dominance of the Upland factor for fuzzy seeds over the Egyptian factor for smooth seeds, whereas in combination 3 the Upland factor for fuzzy seeds was recessive to the Upland factor for smooth seeds. Since the same (doubtless homozygous) Upland family furnished the fuzzy-seeded parents of both combinations, it may be concluded that different factors for smooth seeds occur in Egyptian and in Upland cotton. It also seems probable that the slightly fuzzy condition of the smooth-seeded

Egyptian is recessive to the naked or nearly naked condition of the smooth-seeded Upland, since in the cross between a smooth-seeded Egyptian and a smooth-seeded Upland (combination 7) 85 per cent. of the smooth-seeded segregates in $F_2$ had the seeds naked or very nearly so.

The factor for smooth seeds in Egyptian (Pima), although recessive to the factor for fuzzy seeds in Upland, is dominant to the factor for fuzzy seeds in Egyptian (Pima), as was shown in the earlier pages of this paper. The occurrence of modifying factors or intensifiers for fuzziness is indicated by the results from crosses of fuzzy Pima with fuzzy Upland (combinations 4, 5, and 6). That such a factor, or factors, may be carried by a plant homozygous for the major factor determining smoothness as contrasted with fuzziness is suggested by the results of the cross between fuzzy Pima and smooth Upland (combination 8).

The crosses described in the early pages of this paper had for their parents members of a Pima Egyptian family homozygous for both smooth seeds and normally spotted petals, and members of another Pima family homozygous for both fuzzy seeds and almost spotless petals. Complete independence of the characters, smooth and spotted, is demonstrated by the results of these crosses.

Crosses made by Ballard between members of a family of Upland cotton having fuzzless seeds and sparse lint, and members of an Upland family having entirely fuzzy seeds and abundant lint, gave satisfactory evidence of complete, or nearly complete, linkage of fuzzless seeds and sparse lint. The results confirm those which Thadani obtained with a similar cross.

137. Cotton-Growing Policy: The Influence of Climate on Staple Quality. By E. E. Canney. (*J. Text. Inst.*, xviii. Special issue, September, 1927, T. 454.)

138. A Contribution to the Method of Appreciating Cotton Seasons. By G. S. Zaitzev. (*Trans. Turkestan Plant Breeding Station, Tashkent*, No. 10, 1927.) (In Russian, with the following conclusions of the author given in English.) Taking into consideration the fact that under the conditions of Central Asia the chief factors determining the yield are the general length of the growing season and its meteorological conditions, the author endeavours to determine the length of separate growth phases of the cotton plant, and, judging from the observed acceleration or retarding in connection with the meteorological conditions, to determine the probable number of maturing and dehiscing bolls. The chief phase determining very definitely the prospects of the season is the phase of budding—*i.e.*, the time of appearance of the first buds. The determination of this phase (its early or late arrival) gives the possibility of forecasting all the following phases, and also the probable value of dehiscence of the bolls, or, according to the term used by the author, "the height of dehiscence-hd." (*i.e.*, the height of the fruiting branch whose bolls can grow to dehiscence), which determines the value of the yield for definite types of fruit formation.

139. Works of the Turkestan Plant-Breeding Station and some Summary of Cotton Selection Tests and of Seed Cotton Variability. (In Russian.) By G. S. Zaitzev. (*Trans. Turkestan Plant-Breeding Station, Tashkent*, No. 8, 1927.) A Report on the VII. All-Union Cotton Conference.

140. The Moisture Equivalent of Heavy Soils. By A. F. Joseph. (*J. of Agr. Sci.*, xvii., 1, 1927, p. 12.)

141. The Organic Matter in Heavy Alkaline Soils. By A. F. Joseph and B. W. Whitfield. (*J. of Agr. Sci.*, xvii., 1, 1927, p. 1.)

## *CO-OPERATION.*

142. Co-Operative Societies. Duties of the Committee, Sureties, and Members of a Credit Society of Unlimited Liability. (*Dpt. of Agr. Ceylon, Co-op. Leaflet*, No. 7. *Trop. Agriculturist*, lxix., 2, 1927, pp. 118-120.)

## *CHEMISTRY AND PHYSICS.*

143. The Application of Sulphur Colours to Raw Cotton. By H. M. Chase. (*Text. Rec.*, xlv., **536**, 1927, p. 61.)

144. "Alkaline" American Cotton: Combing. Southern Textile Assn. (Carding Division). (*Cotton*, U.S., 1927, **91**, 531. Abstr. from *J. of Text. Inst.*, xviii., **10**, 1927, A. 320.) A complaint is made that some Western cotton contains "alkali" which, with a certain humidity, becomes moist and sticks to the rolls, especially on the combing machines, so that they will not run. A theory was offered to the effect that in cotton raised in irrigated country the sun dries up the moisture inside the cotton hair so quickly that the cells have not time to absorb the solid matter which is left inside the hair; in the mill the hairs absorb moisture, which causes them to swell. One speaker stated that he had experienced the trouble with Pima cotton, and had found it necessary to keep the humidity down to 55 per cent., as against 60 to 65 per cent. for Sakel. Chemical analysis showed practically no difference between Pima cotton from Arizona and the South Carolina cotton. A thin coat of varnish applied once a week to the rolls overcame the trouble for another man, using 55 to 60 per cent. humidity. In another mill it was found necessary to run a five-tooth larger tension gear on the drawing on Arizona Pima cotton than on Sea Island and Sakel before the same breaking strength could be obtained.

145. Balls Sorter and Johannsen Sorter: Application. By W. E. Sotikoff. (*Bibliotheka Chlopkowogo Djela*, 1927, No. 6, 64-81. Abstr. from *Summ. of Curr. Lit.*, vii., **18**, 1927, L. 27.) A comparison has been made of the Balls sorter and the Johannsen sorter. With careful working, the two instruments give almost identical results. The Balls sorter is more accurate, whilst the Johannsen sorter gives results which are clear at a glance, so that the former is suitable for accurate scientific investigations, and the latter for demonstration purposes. The Balls sorter is indispensable when numerical returns of precise measurements are required—for example, in ascertaining the deviation of a sample from a standard cotton. In mill practice both sorters may find useful application.

146. Cotton: Adsorption of Water Vapour. By H. Bradley. (*Nature*, 1927, **120**, 82. Abstr. in *Summ. of Curr. Lit.*, vii., **16**, 1927, C. 54.)

147. Cotton Fabrics. By W. Hough. (Fourth Edition. Published by John Heywood, Ltd., Manchester. 4s. Abstr. in *Jour. of Text. Inst.*, xviii., **8**, 1927, P. 190.) The major portion of this book is devoted to an encyclopædia of cotton fabrics, occupying fifty-eight pages.

148. Cotton Fabric: Mercerizing. By M. Melliand (Heidelberg). (E.P. 273327 of June 25, 1926. Abstr. from *Summ. of Curr. Lit.*, vii., **17**, 1927, K. 109.) The material is subjected to two or more interdependent treatments with concentrated bases, such as mercerizing liquors, the liquors being used alternately hot and cold in any desired sequence, the action being stopped in each case immediately after the structural alterations of the filaments desired have been effected. In the treatment of cotton materials, the ordinary mercerizing processes

may be used, and may precede or follow treatment according to E.P. 254695. In an example, ordinary cotton muslin is mercerized in the usual manner to form lampshade lining, then treated for 3 minutes with 43 per cent. caustic soda lye at 92° C. Immediately after the structural change is effected, the lye is displaced by boiling water, and, should the product not be satisfactory, it is impregnated for a short time with 25° Bé. caustic soda lye at 18° C., this in turn being removed without stretching the material. If the lye used for the hot treatment is of higher concentration—*e.g.*, 60 per cent.—the feel of the material becomes somewhat fuller.

**149.** Wool-Finished Cotton Fabric. By L. Lilienfeld (Vienna). (E.P. 274860 of July 20, 1926. Abstr. from *Summ. of Curr. Lit.*, vii., **18**, 1927, K. 118.) Cotton fabric having the soft feel of wool, and from which creases and wrinkles are readily removed by simply brushing or smoothing, is produced by treating the fabric in an unstretched condition with gaseous or liquid carbon bisulphide, and then with alkali lye, or by treating the fabric in an unstretched condition with a mixture of emulsion of carbon bisulphide and alkali lye. The material may be deposited in folds on a travelling apron in order that it may be free to shrink. The carbon bisulphide may be diluted with a solvent such as benzine. The cotton fabric to be treated may be unbleached or bleached and mercerized.

**150.** Cotton Mixing. By H. Bruggemann. (*Melliand Textilber.*, 1927, **8**. Abstr. from *Jour. of Text. Inst.*, xviii., **8**, 1927, A. 257.) A general article on the opening and mixing processes.

**151.** Cotton Opener: Description. By L. Wild and F. Quinn. (E. P. 276493 of August 18, 1926. Abstr. in *Summ. of Curr. Lit.*, vii., **21**, 1927, F. 32.)

**152.** Opening, Combing, and Cleaning Machine: Cotton. (*Text. Merc.*, 1927, **76**, 504. Abstr. from *Jour. of Text. Inst.*, xviii., **8**, 1927, A. 291.) A description of a machine for treating cotton, cotton waste droppings, and other fibrous material, and which is particularly suitable for users of low-grade leafy cotton and waste.

**153.** Cotton Waste: Utilization. By C. G. A. Lundberg. (E.P. 271076. Abstr. in *Summ. of Curr. Lit.*, vii., **15**, 1927, K. 103.)

**154.** Cotton Yarn. Effect of Organic Acids. By E. Ristenpart and K. Petzold. (*Leipziger Monats. Text.-Ind.*, 1927, **42**, 389-90. Abstr. in *Summ. of Curr. Lit.*, vii.. **21**, 1927, K. 132.)

**155.** Cotton Yarn. Tendering by Acid. By F. C. Wood and E. Butterworth. (*J. Soc. Chem. Ind.*, 1927, **46**, 375-8T. Abstr. in *Summ. of Curr. Lit.*, vii., **19**, 1927, B. 85.)

**156.** Cotton Yarns: Lea Strength, Staple Length, and Counts. By A. N. Sheldon. (*Text. World*, 1927, **72**, 314-16. Abstr. in *Summ. of Curr. Lit.*, vii., **16**, 1927, L. 24.)

**157.** Egyptian Yarn: Mercerizing and Bleaching Losses. By F. Pichler. (*Melliand's Textilberichte*, 1927, **8**, 853-5. Abstr. in *Summ. of Curr. Lit.*, vii., **21**, 1927, K. 132.)

**158.** The Fixation of Atmospheric Nitrogen. By J. M. Braham. (*Amer. Electrochem. Soc. Trans.*, 48 (1925). Abstr. from *Exp. Sta. Rec.*, lvi., **7**, 1927, p. 623.) In a contribution from the U.S. D.A. Fixed Nitrogen Research Laboratory, the growth and present trend in nitrogen fixation are discussed, together with some of the newer developments in the industry, and the kind of nitrogen products being made available to agriculture from air nitrogen processes. Three processes are now producing nitrogen compounds for fertilizer use. The synthetic ammonia process is considered to be the most important at present, and is used for over two-thirds of the total nitrogen fixed. The process is dependent upon a large supply of cheap hydrogen, and the cataclyst is a very important factor. The arc process is dependent upon large quantities of cheap electrical power, and produces only 6·4 per cent. of the total nitrogen fixed.

159. IMMUNIZED AND AMIDIZED COTTON. (*Text. Merc.*, 1927, **76**, 504. Abstr. in *J. Text. Inst.*, xviii., **10**, 1927, A. 334.)

160. MÉTHODE D'APPRÉCIATION DES DIVERSES QUALITÉS TECHNOLOGIQUES DES FIBRES D'UN COTON. By F. Heim de Balsac and O. Roehrich. (Abstr. from *Coton et Culture Coton.*, i., **1**, 1926, Section 2, p. 1.) The textile section of the Laboratory of Colonial Products has been occupied since 1921 in devising a method of estimation of the technological qualities of cottons that shall be at once scientific and practical. An excellent and simple account is given (in French) of the methods of determining length, fineness, colour, etc. The paper ends with a comparative table of these qualities in various types of cotton, and with a bibliographical index.

161. COTTONSEED: GRADING. By G. S. Meloy. (*Oil and Fat. Ind.*, 1927, **4**, 307-14. Abstr. from *Summ. of Curr. Lit.*, vii., **20**, 1927, B. 89.) The colour of the kernels, which is the basis of the cutting method of determining damage in cottonseed, has no apparent relation to the quality of the oil produced. The direct determination of the free fatty acid content of the oil from a sample of the seed has a direct relationship to the colour and manufacturing loss in the oil. In purchasing seed for crushing, the kernel or meats content is the principal factor. This claim—namely, that the net kernel content is an index to the value of the seed—is based on experimental evidence.

162. COTTONSEED GOSSYPOL: DESTRUCTION. By W. D. Gallup. (*Ind. Eng. Chem.*, 1927, **19**, 726-28. Abstr. from *Summ. of Curr. Lit.*, vii., **16**, 1927, B. 71.) Gossypol, the toxic principle of cottonseed, is slowly destroyed by heating in an electric oven at 100° C. if the seed is first ground and spread in thin layers. It is rapidly destroyed by steaming the seed, as in autoclaving in the presence of excess moisture. The seed was soaked in water for 4 hours, and autoclaved at 20 pounds steam pressure; 1 hour was sufficient to reduce the gossypol content, so that it could not be determined by the usual chemical methods. Germination does not decrease the toxicity of cottonseed.

163. THE GOSSYPOL CONTENT AND CHEMICAL COMPOSITION OF COTTONSEEDS DURING CERTAIN PERIODS OF DEVELOPMENT. By W. D. Gallup. (Abstr. from *J. Agr. Res.*, xxxiv., **10**, 1927, p. 987.) The gossypol content and chemical analyses of cottonseeds of the variety Oklahoma Triumph 44. picked at different stages of development, are reported. The seeds were obtained at the different stages from the time the boll was ready to open until it had fully opened, and also included those seeds which had remained in the field unpicked for several months. The greatest change in the composition of the seeds over the range studied occurred at the time the boll was mature and about to crack, from which time until the boll opened the gossypol content increased rapidly, and continued to increase for some time thereafter. This increase in gossypol was greater than the increase of any of the other constituents, all of which showed only small increases after the boll had opened. No correlation was found between the formation of oil and the formation of gossypol.

164. COTTONSEED MEAL FOR MAINTAINING, GROWING, AND FATTENING HOGS. (*Texas Sta. Rpt.*, 1926. Abstr. from *Exp. Sta. Rec.*, lvii., **2**, 1927, p. 172.) Twelve pigs were placed in dry lot at a weight of 89·8 lb., and fed for 70 days on the

following ration: Ground milo, 75 parts; grey wheat shorts, 10 parts; prime cottonseed meal, 15 parts; and 2 parts of a mineral mixture composed of 75 per cent. of bone meal and 25 per cent. of salt. While on tests these pigs made an average daily gain of 1·32 lb. per head, and required 377·8 lb. of feed per 100 lb. of gain. Pigs on a properly balanced diet have made good and economical gains when fed with cottonseed meal. When fed with milo it has been found beneficial to supplement cottonseed meal with minerals.

165. COTTONSEED MEAL, COLD-PRESSED CAKE, AND LINSEED-OIL MEAL IN RATIONS FOR FATTENING CATTLE. By H. M. Garlock. (*Missouri Sta. Circ.*, 153, 1927. Abstr. in *Exp. Sta. Rec.*, lvii., 3, 1927, p. 267.)

166. THE CHEMICAL COMPOSITION OF COTTONSEED OIL FROM THE UPLAND TYPE OF SEED. By G. S. Jamieson and W. F. Baughman. (*Oil and Fat Indust.*, iv., 4, 1927, pp. 131-33. Abstr. from *Exp. Sta. Rec.*, lvii., 3, 1927, p. 203.) A study of the components of the oil from the Upland type cottonseed is reported, in which the glyceryl esters of the more important fatty acids were determined. These are presented in comparison with corresponding data for oil from the Sea Island type of cottonseed, the data being for the most part strikingly similar. The largest difference is in the percentage of oleic acid, the Upland oil yielding 30·5 per cent. of oleic glyceride, while the Sea Island oil gave 35·2 per cent. Of linolic glyceride, the Upland oil yielded 44·8 and the Sea Island 41·7 per cent.

167. SORGO SILAGE, SORGO FODDER, AND COTTONSEED HULLS AS ROUGHAGES IN RATIONS FOR FATTENING CALVES. By J. M. Jones *et al.* (*Texas Agr. Exp. Sta. Bull.*, 363, 1927.) In each of the three tests carried out, sorgo silage and sorgo fodder produced larger gains than cottonseed hulls when fed to fattening calves. The average gain per head for the calves fed silage was 361·4 pounds; for calves fed cottonseed hulls, 291·8 pounds; and for those fed chopped sorgo fodder, 345·1 pounds. (Sorgo is the name given to the sweet sorghums by the U.S. Dpt. of Agr. to distinguish them from the grain sorghums.)

[Also *cf.* 3.]

## *MISCELLANEOUS.*

168. IMPERIAL AGRICULTURAL RESEARCH CONFERENCE. From a summary of the opening speech delivered at the Imperial Agricultural Research Conference at Westminster on Tuesday, October 4, by the Minister of Agriculture, the Rt. Hon. Walter Guinness, M.P., we extract the following: "Agriculture is our largest Empire industry. Its output in our own crowded island reaches a value of £225,000,000 a year, and when one realized that in the vast overseas territories of the Empire 80 per cent. were living by agriculture, that industry would be seen as the giant pillar of its life and prosperity. We lived in a time of complexity and change, and those industries which stood still were quickly left behind. We must look to research to improve the results of industry. By this means alone could a better standard of living be secured." Among the past triumphs of research, Mr. Guinness mentioned the discovery of artificial fertilizers, the application to agriculture of Mendel's principles of heredity in plant and animal breeding, and Sir Arnold Theiler's work on animal diseases in South Africa. At present the efficiency of plants as transformers of the sun's energy was for the best field crops only about 1 per cent.—far behind the worst motor-car engine. Research might show a way of raising the return of the soil for human labour. Great results might also come from the control and taming to human purposes of the vast population of micro-organisms in the soil. Already new discoveries in this direction had enabled them to inoculate leguminous plants, artificially to convert straw into manure, and to get favourable results from a partial sterilization of the soil. The Conference would have an opportunity of seeing

on the spot the agricultural research organization which had been developed in this country under the guidance of Sir Daniel Hall, largely within the last eight years. Although Great Britain could not compare with the United States in the money spent or the magnificence of equipment, he hoped that they would be convinced that there was no need to look to another country as the Mecca of agricultural research. The work of the Conference would be inspired by the idea of mutual help to secure that on the ocean of agricultural research a man should not voyage alone if there was a fellow-voyager by whose companionship he could be helped and inspired.

**169.** COTTON. By H. B. Brown. (New York and London: McGraw-Hill Book Co., 1927. Abstr. from *Exp. Sta. Rec.*, lvii., 3, 1927, p. 227.) This book endeavours to summarize information on the most important aspects of cotton and the cotton industry, the material applying especially to the Upland cotton district of the American Cotton Belt. A brief historical survey is followed by a discussion of the cotton plant in various relationships—its botanical species, agricultural varieties, morphology, physiology, reproduction, and heredity, and a discussion of subjects relating to cotton production—cotton breeding, fertilizers, soils, climate, culture, diseases, harvesting, and ginning. Phases of cotton marketing—classing, cotton marketing proper, and cotton exchanges—are reviewed, and the products and uses of different parts of the cotton plant are discussed. Concluding chapters deal with uses and spinning qualities of various kinds of cotton, making cotton cloth, and cotton statistics.

**170.** SKINNER'S COTTON TRADE DIRECTORY OF THE WORLD, 1927-28. (London, Manchester, and Bradford, October, 1927. 30s. net.) This is an all-embracing directory of the cotton trade, as is illustrated by the following list of the thumbholes cut in the 1,548 pages to facilitate speedy reference: Contents, Advertisement Index, Exporters, Merchants and Brokers, Waste, Spinners and Manufacturers—Great Britain, including a list of Directors, etc., United States, Germany, France, Italy, India, China, Japan, Other Countries—Yarns, Piece Goods, Fabrics, Artificial Silk, Mill Supplies, Machinery, Electrical, Chemical. The information under each head is given in the most careful detail, with titles of firms, addresses, capital, number of spindles, list of manufacturers, and so on. The book is indispensable to all engaged in any way in the cotton trade.

**171.** THE COTTON WORLD: A SURVEY OF THE WORLD'S COTTON SUPPLIES AND CONSUMPTION. Compiled and Edited by John A. Todd. (Published by Sir Isaac Pitman and Sons, Ltd., Parker St., Kingsway, London. Price 5s.) This book, which contains the substance of lectures given (not only by the Editor, but by a number of leading authorities upon the Liverpool cotton market) to students in the Liverpool School of Commerce, is one of the best general accounts we have seen that includes not only the growing, but the marketing, spinning, and weaving of cotton. We have read it with great interest from end to end. It should be in every library that has to do with cotton.

**172.** THE SCOTTISH COTTON INDUSTRY. By W. Watson. (*Text. Rec.*, xlv., **535**, 1927, p. 47.)

**173.** THE LANCASHIRE COTTON TRADE AND FOREIGN COMPETITION. By S. S. Hammersley, M.P. (*Text. Rec.*, xlv., **533**, 1927, p. 84.)

**174.** EFFICIENCY AND COTTON MANUFACTURE. By W. Wilkinson. (*Text. Rec.*, xlv., **533**, 1927, p. 87.)

**175.** CHINESE COTTON MILL: PRODUCTION COSTS. By A. Easton. (*Text. World*, 1927, **72**, 441-44. Abstr. from *Summ. of Curr. Lit.*, vii., **16**, 1927, G. 59.) Details are given of the staffing of a typical Chinese cotton-spinning mill, wages, production, production costs, and relative efficiency. The efficiency of the workers is low, and the number of workers employed is exceptionally high, so that cotton-spinning is comparatively unprofitable. The usual counts spun in the Shanghai district are about 16's to 20's. The cotton used is mostly Chinese, of which Shensi appears to be the best and Tungchow the second.

176. COTTON BAGGING WOULD INCREASE COTTON CONSUMPTION 750,000 BALES. (*Cotton*, September 26, 1927.) Advices from Washington state that increased consumption of 750,000 bales of American cotton, through the use of cotton bags to replace bags now made of other materials for the wholesale grocery trade, is seen as a possibility by the U.S. Department of Agriculture cotton specialists, who have just concluded a survey of the situation.

It is roughly estimated that 225,000 bales of raw cotton and cotton waste go annually into the manufacture of cotton bags, most of which are used in the grocery trade. The estimated quantity of bags made of materials other than cotton used in one year by wholesale grocers, which the wholesale grocers think might be replaced advantageously by cotton, totals nearly 329,000,000 lb. Pound for pound, this is equivalent to approximately 787,000 bales of raw cotton.

Experiments have also recently been made by the U.S. Department of Agriculture in having cotton bales tared with cotton bagging, which reduce the weight of tare to roughly 6 lb., against 22 lb., which is the weight of the present jute covering; also, it is claimed that the cotton does not adhere to the cotton covering, as in the case of jute, and more effectively protects the raw cotton. A consignment of bales tared with cotton covering was recently made to Bremen.

177. CLEARING LAND OF BRUSH AND STUMPS. By G. R. Boyd. (*U.S. Dpt. Agr. Farmers' Bull.*, No. 1526. Obtainable from Supt. of Documents, Govt. Printing Office, Washington, D.C. Price 5 cents per copy.)

178. SUCTION GAS TRACTORS. By P. H. Haviland. (*Rhod. Agr. Jnl.*, xxiv., 9, 1927, p. 967.)

179. We have received from the Cotton Committee of Moscow a copy of vol. vii. of the journal *Cotton Industry*, containing a collection of articles (in Russian) on raw cotton problems.

180. JAPAN: COTTON OPERATIVES. LABOUR CONDITIONS. (*Bull. Hygiene*, 1927, 2, 636. Abstr. from *Summ. of Curr. Lit.*, vii., 16, 1927, M. 24.) Factory inspection in Japan is comparatively modern, since the original Factory Act only dates from 1911. In the textile industries the hours of employment are generally 12 a day, and day and night shifts are worked. A Sunday rest is not observed, but two holidays a month are usually given. New factories are well equipped, and many have hygienic dormitories attached for workers coming from a distance. Special attention is now paid to the prevention of industrial disease.

181. COTTON FACTORIES: WELFARE SUPERVISION. By W. F. Dearden. (*Bull. Hygiene*, 1927, 2, 616. Abstr. in *Summ. of Curr. Lit.*, vii., 16, 1927, M. 23.)

182. COTTON OPERATIVES: HEALTH HAZARDS. By W. F. Dearden. (*Bull. Hygiene*, 1927, 2, 616. Abstr. in *Summ. of Curr. Lit.*, vii., 16, 1927, M. 23.)

And *cf.* Abstract 46.

183. From the French Embassy we have received a copy of *Règlement General pour l'Exposition Coloniale Internationale de 1929 à Paris*. The Exhibition is international, and the products of the British Colonies may be entered. A general classification of the Exhibition is given on p. 19, and the reprint gives the rules under which objects must be exhibited.

## ADDENDUM.

**184. East Africa.** *Railway Charges.* We have received from H.M. Eastern African Dependencies' Trade and Information Office a copy of a cable from East Africa stating that from December 1 substantial reductions will be effected in rates on the Kenya and Uganda Railway System. One of the principal reductions will be in the rates for kerosene and paraffin, which is a matter of great interest in connection with the cheapening of the price of power media with regard to the growing mechanism of agriculture in Kenya and Uganda.

# PERSONAL NOTES

We much regret to announce the death of two members of the Empire Cotton Growing Corporation:

Mr. J. C. Parker, who represented the United Textile Factory Workers' Association on the Council of the Corporation, and was also a member of the Executive Committee.

Mr. Arthur Sidebottom, one of the representatives of the Federation of Master Cotton Spinners' Associations on the Council of the Corporation.

## APPOINTMENTS.

In addition to the appointments made by the Corporation from among the holders of Senior Studentships last year, mentioned in the October issue of the REVIEW, positions have been secured by the remaining men as under:

Mr. D. W. H. Baker has received an appointment in the Agricultural Department of the Sudan.

Mr. W. P. K. Findlay has obtained a post as Mycologist under the Forest Products Research Board.

Mr. M. Greenwood has been appointed to a post as Chemist in the Agricultural Department, Nigeria.

Mr. T. Lloyd Williams has received an appointment as Botanist in the Gold Coast.

Mr. U. J. Moffat has been appointed jointly by the Northern Rhodesian Government and the Corporation as Agricultural Officer in the Abercorn District of Northern Rhodesia.

## OFFICERS ON LEAVE.

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes "home" on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton. The Corporation would consequently much appreciate the courtesy if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would call at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street) immediately opposite the offices of the Crown Agents for the Colonies.

At the date of writing the following officers are on leave in England from cotton-growing countries:

| | |
|---|---|
| Gold Coast .. .. .. .. | Mr. T. Hunter. |
| " .. .. .. .. | Mr. C. Saunders. |
| " .. .. .. .. | Captain J. M. Wingate. |
| Kenya Colony .. .. .. | Mr. A. S. Hartley. |
| Nigeria .. .. .. .. | Mr. K. T. Rae. |
| " .. .. .. .. | Mr. D. H. Urquhart. |
| Sierra Leone.. .. .. .. | Mr. R. R. Glanville. |
| Tanganyika Territory .. .. | Mr. A. H. Kirby. |
| Uganda .. .. .. .. | Mr. C. Hazel. |
| " .. .. .. .. | Mr. A. R. Morgan. |

Mr. G. S. Cameron, the Corporation's Cotton Specialist in Southern Rhodesia, is also on leave in this country.

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# NEPPINESS IN COTTON

SOME recent correspondence with a member of the Corporation staff on the subject of this Note has led us to believe that a short description of the cause of neppiness in cotton and its detection might prove useful to those engaged on cotton selection and similar work in different countries. The following Note consists, for the most part, in an attempt to summarize experience gained by the Shirley Institute, and further details are available in publications by members of their staff. We also gratefully acknowledge our indebtedness to the Shirley Institute for the excellent microphotographs, reproductions of which serve to illustrate this article.

A cotton hair on the seed practically completes its longitudinal growth before any secondary thickening of the hair wall takes place, and this latter is a gradual process, daily growth layers being deposited over a period of twenty to thirty days. It is thus possible to find hairs in all stages of development in varying proportion. If there is some interference with the normal development of the lint, such as unsuitable climatic conditions, insect and fungus attack, what is called immature or dead cotton is the result. In some cases it is an inherent character of the plant to produce this immature lint.

The interference referred to results in a lack of the secondary thickening. It can easily be seen that there must be every gradation through the range, from hairs with no secondary thickening at all, or only the very smallest amount, up to normal hairs. The completely undeveloped hairs can be called immature or " dead "; those more developed, but with less than the normal amount of thickening, are classed as " thin-walled." There are thus three classes into which hairs can be placed simply for the sake of convenience, although it cannot be too strongly emphasized that they grade almost imperceptibly into each other.

These three classes are: (1) Immature or " dead " cotton; (2) thin-walled cotton; (3) normal cotton.

The frequent use of the word "dead" in this connection is apt to be very misleading, but the long conventional and synonymous use of the words "dead," "immature," and (by some people) "unripe" necessitates its retention in any classification of cotton hairs.

In samples of good cotton, under-developed hairs of course exist, but their proportion is small. Hairs do not ripen simultaneously—they cannot very well do so—but the resulting range of wall thickness, due to a difference of a few days one way or the other in the ripening, probably does not have much effect on spinning value.

On the other hand, cottons containing a large amount of thin-walled lint are often found to contain also an excess of short hairs, and to be very irregular in staple. To account for this, the suggestion is made that these thin-walled hairs suffer breakage in the ginning and baling, and thus give rise to a large proportion of short fibres.

Sometimes growth is arrested before the hairs have reached normal length, in which case the lint is both abnormally short and lacking in secondary thickening. In very bad cases the immaturity can actually be distinguished by naked eye examination. It is characterized by the peculiarly glassy lustre of the hairs concerned, which occur generally in bunches, and often with fragments of seed attached.

From the trade point of view, probably the chief interest of all this lies in the "neppiness" that such cottons as those last described exhibit. The term "nep" is used in many different senses, and it is necessary to distinguish between the neppiness which is a defect of the raw cotton, and the neppiness produced in any one or other of the processes through which the cotton passes. It is not the type caused by a defect in the machinery, but the inherent type which is now under review.

The "neps" in question consist of, or have a nucleus of, immature ("dead") cotton, although sometimes fuzz or seed coat is there acting in the same way. As understood by the industry, "neps" may enclose foreign matter, seed fragments called motes, with fuzz and with thin-walled hairs attached.

Another feature is often called "curl" by the spinner, and it indicates stringy bunches or masses of cotton consisting of thin-walled hairs, and sometimes also of immature hairs. These "rat-tails," as they are occasionally named, from their stringy appearance, may even occur in a healthy cotton of unusual fineness, being formed in that case of normal but very fine hairs. It is obviously not possible to say that "neps" consist of one type of cotton and "curl" of another, for they can both contain under-developed hairs.

# AFTER TREATMENT WITH 18 PER CENT. CAUSTIC SODA.

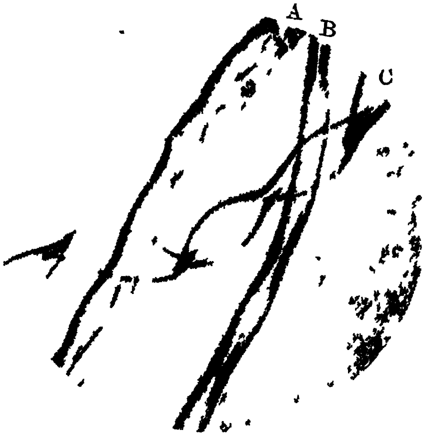

FIG. 1.—(A) NORMAL HAIR (ROD-LIKE FORM); (B) THIN-WALLED HAIR (SOME CONVOLUTIONS); (C) "DEAD" HAIR (VERY MARKED CONVOLUTIONS).

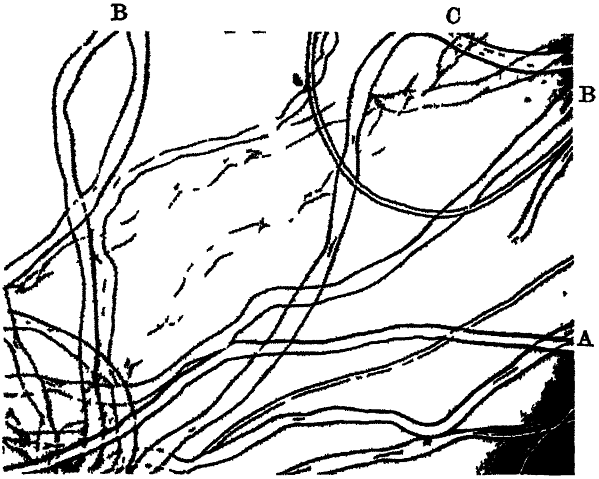

FIG. 2.—SAMPLE TUFT OF COTTON SHOWING THREE TYPES.

It is a matter of considerable difficulty to obtain any strictly quantitative idea of the amount of dead or immature and thin-walled cotton in a sample. Lint-length frequency diagrams sometimes indicate the presence of an excessive number of short hairs, often a characteristic property of under-developed cotton; but it may well happen that the variability is due to some other cause. Further, hair weight per centimetre and breaking load figures often fail to reveal the fault, because these measurements are carried out on centimetre lengths, and the weak, immature (" dead ") and thin-walled cotton—probably broken in the preparatory process—is for that very reason not included. Examination of transverse sections of the hair is unsatisfactory for the same reason; these hairs, again, are broken in preparation and do not appear in the final sample.

A simple method of determining the proportions present by judgment is, however, often used. It depends upon the following phenomena. The convolutions (twists) of a hair have been found to depend on the ratio between the thickness of the wall and the total width of the hair. If this ratio is very small—*i.e.*, if there is little or no secondary thickening as in very immature (" dead ") cotton—the hair is a flat ribbon with no convolutions. If, on the other hand, the ratio is large the hair has a rod-like form, and if normal the hair is regularly convoluted. Now the effect of swelling with 18 per cent. caustic soda is to increase the wall thickness, thus shifting all normal hairs into the rod-like class. On this showing hairs which still retain some convolutions after treatment must be thin-walled. Immature (" dead ") hairs with only a little secondary thickening convolute on treatment in a very obvious way, while if they have no secondary thickening at all they remain flat and glassy.

The illustrations of microphotographs show these types after the action of the caustic soda.

1. Normal hairs showing rod-like form.
2. Thin-walled hairs retaining some convolutions.
3. Immature (" dead ") hairs showing (*a*) their very characteristic convolutions and (*b*) the extreme type of immature hair remaining flat.

Thus mere inspection after treatment of a sample with 18 per cent. alkali will often suffice to demonstrate the presence of under-developed cotton, or a count may be made on 100 hairs taken at random from a sample made up of many small tufts from the cotton under examination.

# IRRIGATION AND CROP PRODUCTION

BY

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## INTRODUCTION.

CROP yield can be regarded as a measure of the success of agricultural operations in overcoming factors limiting plant growth. Under natural conditions, systems of agriculture which give optimum yields have been developed as the result of experience, the system representing a condition in which the factors operating for and against crop yield have been stabilized.

The introduction of a system of perennial irrigation has frequently been followed by a reduction in crop yield, the yield probably becoming stabilized at a point below the optimum. This indicates that under the artificial conditions of irrigation the balance of the factors determining crop yield is disturbed, or new factors operating against crop yield are introduced. In some cases this may be attributed to the accumulation of salts, such as sodium chloride, in the soil, but in others, the reason for the decline in yield is not so obvious. A thorough knowledge of the agricultural conditions imposed by a system of perennial irrigation is of great importance if crop yields are to be maintained. This is particularly the case at the present time, in view of the fact that irrigation systems are being developed on a large scale in the British Empire.

The climatic conditions determining plant growth are rainfall and temperature. If the temperature is suitable and there is an adequate rainfall, plant growth will take place. If either the temperature is unsuitable or the rainfall is deficient, plant growth ceases. Irrigation is, therefore, practised in areas where the temperature factor for growth is favourable, but the rainfall badly distributed or deficient.

Irrigation may be regarded from two points of view: the engineering—dealing mainly with the problems of the storage and distribution of water; and the agricultural—dealing with the use of the stored water. As a rule, irrigation is mainly considered from the engineering standpoint, the amount of water stored and the area irrigated being taken as the index by which the success, or otherwise, of the irrigation scheme is judged. This would be a legitimate conclusion if water were the only factor that could limit yield. But since crop yield is largely influenced by soil conditions—chemical, physical, and biological—and since the soil serves as the medium through which the plant obtains the water supplied by irrigation, it is necessary to consider the effects of irrigation on the soil if the factors determining the efficient use of an irrigation system are to be thoroughly understood. Again, irrigation necessitates an alteration in the agricultural system of the irrigated area by the introduction of further crops into the rotation. The introduction of these crops reacts on the agricultural system as a whole, and may necessitate alterations in cultural conditions. A further point that must also be considered is the alteration in the climatic conditions—the soil climate and crop climate—in the irrigated area, and the effect of these changed conditions on plant diseases and insect pests. It will be seen, therefore, that before an expensive system of irrigation can be introduced with confidence, a large number of interdependent factors must be taken into consideration. At the present time, little is known of the relation of irrigation to these factors, and hence crop production under a new system of irrigation has not a solid foundation. The true index of the success or otherwise of any irrigation scheme is to be found, not in the amount of water stored and distributed, but in the yield of crops which result from the use of the stored water. The results of the development of the system of perennial irrigation in Egypt have shown that the storage of increasing quantities of water is not necessarily followed by corresponding increases in the yield of the irrigated crops. On the contrary, the increases in stored water which have been made since the beginning of this century have been followed by marked decreases in yield. The development of an irrigation system is costly, and it is introduced with the object of growing a crop of high value; the importance, therefore, of a knowledge of the factors determining crop yield under irrigation is obvious. In the present paper, some factors influencing crop yield under irrigation will be considered.

## Crop Rotation and Irrigation.

The development of a system of irrigation can alter the crop rotation in two ways—(*a*) by the introduction of further crops into the rotation, and (*b*) by the alteration of the conditions of cultivation of the crops. As the development of the system of perennial irrigation in Egypt affords instances of both of these alterations, they will be illustrated by considering the effect of irrigation on the agriculture of that country.

In order to appreciate the agricultural conditions now existing under perennial irrigation, it is necessary to deal briefly with the history of irrigation in Egypt. From an agricultural point of view, Egypt is rainless except in the neighbourhood of the Mediterranean coast. The production of crops in Egypt has, therefore, always been dependent for water supply upon a system of irrigation. One of the chief characteristics of the Nile is the annual flood, due to rain on the Abyssinian plateau. The flood begins to reach Cairo at the end of July, and is at its height about the end of September. The first type of irrigation used in Egypt was that known as basin irrigation. The land under this type of irrigation was divided into a series of basins by means of dykes. The flood water was led by natural channels or artificial canals into the basins, and allowed to stand in them for a period of about forty-five days. The retention of the water in the basins for this length of time resulted in the thorough saturation of the soil, and at the same time the silt held in suspension was deposited. At the end of the period of forty-five days—that is, in November—the water was run out of the basins into the river, and the land was sown with winter crops. The crops were dependent for their water supply on the subsoil water left as the result of the inundation. The crops were harvested in April and May, after which the stubbles remained fallow until the following flood period in September. One of the main features of the basin system of irrigation was the maintenance of soil fertility as indicated by the constancy of the crop yields. Two characteristics of the basin system of irrigation may have been responsible for the maintenance of soil fertility—(*a*) the annual inundation during which the land received a deposit of Nile silt, and (*b*) the annual fallow period from May till September.

Until recently it was considered that the main factor responsible for the maintenance of soil fertility under the basin system of irrigation was the annual deposit of Nile silt. Experiments recently carried out in Egypt have shown, however, that Nile silt has little manurial value, and that no increase in yield follows a dressing of fresh Nile silt. The cause of the maintenance of the fertility of the soil must, therefore, be sought in the annual fallow period.

The fallow period may be divided into two distinct portions: the first, during which the soil is dried and cracked, and the second, during which the soil is heated. The drying and cracking of the soil is almost complete before the winter crops are harvested. This drying and cracking of the soil has recently been regarded as of fundamental importance in maintaining soil fertility. Under perennial irrigation, the soil on which cotton is grown receives the same amount of drying and cracking as it did under basin irrigation, yet there has been a decline in the yield of cotton. It follows, therefore, that the drying and cracking of the soil have not the *fundamental* importance attributed to them, though they may be beneficial. Investigations on the effect of the heating of the soil during the fallow period have recently been carried out, and indicate that it is due to the heating which the soil received that soil fertility was maintained under the basin system of irrigation. Soil temperatures have been continuously recorded in fallow land from May to September. As a result of a study of these, it has been shown that partial sterilization of the soil due to heat does take place. Further, it has been shown that the partial sterilization of the soil is mainly confined to the period July 1 to August 15. Field experiments on cotton, to be mentioned later, have shown that the yield of cotton is higher when the cotton is sown on land that has been fallow in July and August than when it is sown on land with the fallow curtailed to June 30. The maintenance of soil fertility under basin irrigation must probably, therefore, be attributed to the heating of the soil during the period July 1 to August 15. This is an important conclusion, as will be seen in the discussion of the changes in the agricultural system with the development of perennial irrigation.

The objection to the basin system of irrigation is that the whole of the land is idle for a considerable portion of the year during which the temperatures are suitable for plant growth. The remedy is to supply water by a system of perennial irrigation. The object of perennial irrigation was the introduction of summer cropping and the reduction in the fallow area. The development of the system of perennial irrigation will now be discussed.

Until 1820, such irrigation as was practised in the Nile Delta was of the basin type. The possibility of growing cotton in Egypt was recognized by Jumel. As cotton could only be grown as a summer crop, a water supply was necessary for irrigating the crop. Perennial irrigation was, therefore, established in 1820. with the object of growing cotton. The Nile is low during the summer period, and the channels used for filling the basins were not deep enough to carry water in the low stage of the river. The first step, therefore, in the development of the system of perennial irrigation was the deepening of the channels to take the low level summer water of the Nile. These deep channels had two objections—(1) the whole of the water used for irrigation had to be lifted a considerable distance on to the land, and (2) the canals used to silt up during high Nile, necessitating an annual clearance entailing the use of a large amount of labour. In order to overcome these difficulties, the construction of the Delta Barrages was sanctioned. The Barrages were commenced in 1835, and were first used in 1861, but owing to difficulties that arose, they were not of great value to irrigation until 1884. During the period 1835 to 1884, perennial irrigation was practically maintained by the annual clearance of the deep canals by forced labour. The main developments in the perennial irrigation system have taken place since 1884. In that year, both Barrages were used for the first time. In 1891 repairs to the Barrages were completed, and they held up thirteen metres of water on the gauge. Between 1891 and 1900 the Barrages held up fourteen metres, and since 1901, 15·5 metres on the gauge.

The main result of increasing the amount of water held up at the Barrage has been to convert the country from lift to free-flow irrigation. Since 1901, the perennial irrigation system in Egypt has undergone two further developments. In 1903, the water stored by the Aswan Dam was added to the summer supply of the Nile, and in 1906 it was decided to raise the Aswan Dam so that more water could be stored; this additional supply was added to the river in 1912. As an index of the success or otherwise of the development of the perennial irrigation system, the effect of its development upon the yield of cotton will be considered.

The yield of the first cotton crop in Egypt was about 1,000 kantars. Between 1877 and 1883, the average yield was maintained at 2,500,000 kantars, which represents an average yield per feddan of 3 kantars. The Barrage at this time held up 12·5 metres on its gauge. Between 1884 and 1890, it held up 13·0 metres, and the area under cotton increased to 900,000 feddans, with an average yield of 3·5 kantars per feddan. Between 1891 and 1900, the Barrage held up 14 metres on its gauge, and the average yield of cotton during this period reached 5·5 kantars per feddan. In 1901, it held up 15·5 metres on the gauge, and the average yield fell to 4·9 kantars. In 1903, the water stored in the Aswan Dam became available, and the average yield between 1903 and 1910 fell to 4·5 kantars per feddan. Since 1910, further decreases in the average yield of cotton per feddan have occurred, though now the yield seems to be stabilized.

From 1820 to 1900, each addition to the summer water supply has been followed by an increase in the average yield of cotton per feddan. The development of the system of perennial irrigation which took place during this period must be regarded as having been successful. The development of the irrigation system since 1900 has been followed by a decrease in the average yield of cotton per feddan; developments during this period have, therefore, not been successful. During the successful period of development, as each addition to the water supply was followed by an increased yield, water must have been the principal factor limiting the production of cotton. During the period of unsuccessful development, since additions to the water supply are not followed by increased yields, some factor other than water supply, but dependent for its action on water supply, must be limiting the production of cotton. A study of the agricultural changes which have followed the developments in the perennial irrigation system indicates the cause of the decline in yield.

Under the basin system of irrigation, winter crops only were grown. With the introduction of perennial irrigation, it became possible to cultivate an autumn crop in addition to the winter crops, as the land could be irrigated instead of inundated. Maize was, therefore, introduced. Before the land can be prepared for maize, it must receive an irrigation, since it is impossible to plough the land in the dry state following the summer fallow. Before 1900, the date on which the irrigation for ploughing the fallow land took place depended entirely upon the date on which the annual Nile flood had reached such a height that free-flow irrigation became possible. This date occurred in the month of August. Maize sowing before 1900, therefore, took place between August 10 and September 15. As a result of this, the land on which maize was sown had been fallow from May to August. As cotton is sown in February on land which carried maize the previous autumn, the cotton before 1900 was always sown on land that had been fallow the previous summer. Under these conditions, the fertility of the soil, as indicated by the yield of cotton, was maintained.

Since 1900, a change has been introduced into the method of using the stored water. The Irrigation Report for 1897 states: ' It is further intended to raise the gates of the existing Barrage so that a water level of 15·5 metres may be maintained. *Early sowing of maize will be greatly facilitated,* and all possible advantage taken of the rising flood." The water at the Barrage was retained at 15·5 metres in 1901, and immediately the yield of cotton fell. The Irrigation Report for 1904 states that the fallow ended on *June* 15. The Report for 1909 definitely states the policy of the Irrigation

Service as follows: "The tendency is to hold the reservoir supply later and later every year, so that *the mass of the water is employed to augment the early stages of the flood rather than to increase the volume of the river at its lowest.* The object of the Irrigation Service was, therefore, to use the stored water to obtain an artificially early flood in the river so that maize could be sown early. It is not generally realized that the object of storing water in Egypt is not now the irrigation of cotton, but the preparation of the land for the early sowing of maize.

It will be seen that since the conversion of Egypt from basin to perennial irrigation, two changes have taken place: (1) Increases in the amount of stored water; and (2) a change in the method of using the stored water. The first is an engineering question, but the second—the change in the method of using the stored water—is essentially agricultural. So long as perennial irrigation remained an engineering problem, it was successful, increases in available summer water being followed by increases in the yield of cotton. As soon as an alteration was made in the agricultural system by the introduction of a new method of using the stored water, the yield fell. To the alteration in the agricultural system must be attributed, therefore, the decline in the yield of cotton.

A consideration of the crop rotations under basin irrigation and under the two main periods of the development of perennial irrigation show the main change that has taken place. A comparison of the crop rotations is shown below.

| *Basin Irrigation.* | *Perennial Irrigation* (*Before* 1900). | *Perennial Irrigation* (*After* 1900). |
|---|---|---|
| May to August: fallow. | May to August: fallow. | June to September: maize. |
| August to November: land flooded. | August to November: maize. | October to February: berseem. |
| November to May: wheat, beans, berseem. | November to February: berseem. | February to October: cotton. |
| May to August: fallow. | February to October: cotton. | October to May: wheat, beans, berseem. |
| | October to May: wheat, beans, berseem. | June to September. maize. |
| | May to August: fallow. | |

From a comparison of the crop rotations, it will be seen that under basin irrigation the land was fallow every year between May and August. Under perennial irrigation prior to 1900. cotton was always sown on land that had been fallow from May to August the previous year. During this period of the development of the perennial irrigation system, summer fallow from May to August was still a characteristic feature of the agricultural system. Since 1900, however, the summer fallow has been completely eliminated from the agricultural system, so that the land is now continuously under crop. The change can be expressed as a " crop intensity factor "—that is, the percentage of land under crop in July. This is shown in the following table for the provinces of Lower Egypt:

PERCENTAGE OF LAND UNDER CROP IN JULY IN THE MUDIRIAS OF LOWER EGYPT.

| *Year.* | *Menufia.* | *Qaliubia.* | *Sharkieh.* | *Daqahlia.* | *Behera.* | *Gharbia.* |
|---|---|---|---|---|---|---|
| 1899 | 33·7 | 32·3 | 44·0 | 67·0* | 52·6* | 49·4* |
| 1913 | 99·1 | 93·3 | 96·3 | 95·5 | 85·6 | 88·0 |

* Including rice.

While the increase in the area under summer crops in July is to some extent due to the increase in the area under cotton, it has mainly resulted from the early sowing of maize. It will be seen from these figures that the land is now completely under crop in July, while formerly, during this month, it was fallow. The importance of the fallow period, July 1 to August 15, has already been indicated in considering the maintenance of soil fertility under basin irrigation. The importance of this period in maintaining the yield of cotton was demonstrated in a series of field experiments. In one series of experiments maize was sown early, and in another series maize was sown in August, the whole of the land coming under cotton the following year. After a short fallow, the average yield of the plots was 3·40 kantars per feddan of cotton; after the long fallow, the yield of cotton was 4·39 kantars per feddan. Both the laboratory and field experiments demonstrate the value of the period July 1 to August 15 in maintaining soil fertility. To the elimination of this portion of the fallow by the alteration in the method of using the stored water must be attributed the decline in soil fertility under perennial irrigation as evidenced by the yield of cotton.

The change in the method of using the stored water may be justified from the point of view of food supply. Experiments on the effect of the sowing date on the yield of maize have shown that the maximum yield is obtained when the maize is sown in July. Against the decline in yield of cotton must, therefore, be set the increase in the yield of maize. The experiments indicate, however, that the gain in maize yield does not compensate for the lower yield of cotton, owing to the difference in the money values of the two crops.

The foregoing discussion of the changes that have taken place in the agricultural system of Egypt following the developments of perennial irrigation shows that the factors upon which soil fertility depends must be determined before an irrigation system is developed and retained as essential parts of the new agricultural system. It follows that the result of perennial irrigation cannot be perennial cropping, as has been attempted in Egypt.

## THE QUALITY OF IRRIGATION WATER.

Irrigation water is not pure water, but a dilute solution of salts. This solution has a seasonal variation, both in concentration and in the nature of the salts in solution. These variations may be illustrated by the seasonal variations in the composition of the Nile at Cairo. During the flood period, the amount of salts in solution is at a minimum. From December to May, there is a gradual increase in the concentration of sodium chloride which reaches a maximum of about fifty parts per million. During the summer months, sodium carbonate makes its appearance in the water, which becomes distinctly alkaline. The composition of the Nile water may be important in connection with the alteration that has been made in the method of using it. Formerly, this alkaline water was used for irrigating cotton—that is, a soil that was biologically active. Under these conditions, the sodium carbonate in solution would be rapidly converted to sodium bicarbonate, and " soil deterioration " would be unlikely to result. The present method of using the water is to irrigate a soil that is biologically dormant and hence carbon dioxide production in such a soil would be at a minimum. The result is that the sodium carbonate in the irrigation water remains as such until sufficient time has elapsed for the generation of carbon dioxide to convert it into the bicarbonate. As alkalies deflocculate clay, there will be undoubtedly a temporary deterioration in soil condition which in time may become permanent.

The effect of salts on plant growth has been mainly studied in water cultures or by adding salts in pot experiments, the results being expressed as the toxicity of the salt. If the soil were composed entirely of non-reactive material, these investigations would give results capable of direct application in the field. When a salt is added to a soil, base exchange takes place, and, in nature, some of the products of this base exchange may be either removed or decomposed by the addition of water. The effects of washing out large quantities of salts from a soil, the mode of origin of alkaline soils, and the general behaviour of soils when treated with strong salt solutions, are now fairly well understood. Investigations now being carried out at Cambridge show that with dilute solutions of salts, such as are used in irrigation, secondary reactions set in which alter the results that would be expected from a study of the action of concentrated solutions. As the subject is still under investigation, one point only will be mentioned.

The decline in the crop-producing power of soils under irrigation has frequently been attributed to the action of the salts in the irrigation water. In order to obtain information as to the effect of dilute salt solutions on soil, solutions of sodium chloride varying in concentration from 0 to 200 parts per million were allowed to percolate, under a constant head, through a series of soils, and the rates of percolation observed over a period of some months. The type of percolation curve obtained depended on the concentration of salt solution used. With pure water there was a gradual reduction in the rate of percolation to a stationary figure, the curve being smooth. Solutions varying in strength up to seventy-five parts per million sodium chloride produce a percolation curve which is a wave—that is, the rate of percolation decreases and increases periodically, the percolate at times containing colloidal clay. The final rate of percolation of this type is high. The rate of percolation of solutions between 100 and 200 parts per million sodium chloride is much higher than that of pure water or the more dilute solutions, the curve not being wavy, but showing a gradual decrease in the rate of percolation. The percolate in this case never contains colloidal clay.

The conclusion indicated is that with solutions of less than 100 parts per million sodium chloride, base exchange takes place, but the solution is not of sufficient strength to prevent the hydrolysis of the sodium-clay. The final result is that a sodium-clay soil cannot be produced as the result of the percolation of dilute solutions. With higher concentrations of sodium chloride, hydrolysis of the sodium-clay produced by base exchange is impossible, and hence the sodium tends to accumulate, producing a sodium-clay soil. It appears that, providing an efficient drainage system is supplied to prevent salt accumulation, no soil deterioration need take place with suitable irrigation water. If drainage is not supplied, salt accumulation will take place, sodium-clay will be formed, and soil deterioration will result.

## IRRIGATION AND DRAINAGE.

While the main effect of drainage in removing water from the soil is well known, the water conditions in an undrained soil have not been thoroughly studied. Investigations on drainage now being carried out at Cambridge have an important bearing on the relation between the irrigation water supplied and its effect when it has once entered the soil.

Drainage has usually been studied by means of lysimeters or drain-gauges. A lysimeter consists of an isolated block of soil supported on a perforated iron plate. The water draining from the block of soil as the result of rain falling on the surface can be collected and measured. By means of the lysimeter, the relationship between the rainfall and the amount of drainage can be studied.

The conditions established in lysimeters are those in a perfectly drained soil, and do not represent natural underground conditions. Under natural conditions, water applied to the surface of the soil does not immediately pass into the drains. It causes a rise in the subsoil water-table, the duration of the rise being dependent upon a number of factors, such as soil type and position.

In order to determine the effects of drainage, the result of adding water to the surface of an undrained soil must be studied. The method adopted in the investigation under discussion is to study, in an undrained soil, the effect of adding water to the surface on the subsoil water-table.

The first result of this study has been to show that 1 inch of water placed on the soil surface raises the water-table 4 inches This is readily understood when it is considered that the water on entering the soil can only occupy the pore spaces. As the amount of pore space in the soil investigated was about 25 per cent., the rise in the water-table was four times the depth of water applied at the surface. This experiment was carried out on an undisturbed soil in the field. If arrangements are not made to control this rapid and large rise in the subsoil water-table, the soil soon becomes waterlogged.

A second important result of this investigation is that the rise in the water-table commences immediately water is placed on the soil surface. The water placed on the surface does not flow through the soil to the water-table, but *displaces downwards the water already present in the soil.* The water reaching the water-table is, therefore, the solution which formed the nutritive medium for the plant or, in some cases, contained harmful salts. These results have a direct application to drainage under irrigation. Under irrigation, salts are added to the soil in the irrigation water. If concentration be prevented, soil deterioration will not take place. As the addition of irrigation water to the surface will displace the salt solution, if drainage has been provided, the salts added during one irrigation can be thus displaced into the drains at a subsequent irrigation. The problem involves an investigation of the depth of drainage, the frequency of irrigation, and the quantity of irrigation water to be used. As the soil solution containing the soluble plant food will also be displaced, a consideration of the effect of the above factors on the growing plant will also be necessary.

## Irrigation and Biological Conditions.

As the result of supplying irrigation water and growing a crop, a food supply is provided, and climatic conditions, both in the soil and near the soil surface, altered. These new conditions may be favourable to the development of insect pests, bacterial diseases, and fungi. This is particularly the case when a part of the life-history of an insect is passed in the soil; a possible instance of this is afforded by the Pink Bollworm in Egypt.

The first serious damage by Pink Bollworm was reported in 1913, which means that the pest had been developing for some years previously, although it had not done sufficient damage to attract notice. It has been shown that the most serious uncontrolled carry-over of the Pink Bollworm is in the soil, the greatest danger being from soil on which crops not requiring much irrigation water, such as wheat, are grown. Wheat follows cotton in the rotation. Under the conditions of irrigation before the water in the Aswan Dam became available, the land which had carried wheat remained fallow from May to September. The land was dry, and the temperature to the depth of ploughing was high enough to kill the resting larvæ in July. Under these conditions it is difficult to see how the soil could have been a medium of carry-over; the fallow would actually provide a gap between one cotton crop and the next. Since the Aswan Dam added to the summer water supply, the wheat stubble has been irrigated towards the end of June, and maize sown. The killing of the larvæ in the soil carrying the wheat stubble has thus been prevented, and conditions suitable for the emergence of the insect established. The gap that formerly existed between cotton crops has been bridged by the irrigation of the fallow land which carried cotton the previous year. This possible instance of the alteration of the biological conditions indicates that the relationship of the use of irrigation water to insect pests and diseases is a matter to be considered in connection with the crop rotation under an irrigation scheme.

From the discussion, in this paper, of factors that may limit crop production under irrigation, it will be seen that problems are presented which differ from those connected with crop production under conditions of adequate rainfall. As, however, the supply of irrigation water and the method of using it can be controlled, investigation of the problems would indicate those general conditions most favourable to crop production, and the modifications necessary to deal with the particular factors of each irrigated area.

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# THE BIOLOGICAL CONTROL OF COTTON PESTS

BY

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THE application of biology to the solution of human problems has as yet hardly begun. Haldane has shown that the number of great biological inventions can be counted on the fingers of one hand. It is with an extension of the first, and perhaps the greatest of these—the domestication of animals and plants—that this article will deal.

There are three main ways of combating insects injurious to crops. The first is by some chemical, physical or cultural means to destroy the pest directly. This is often costly, and can rarely be applied on a large scale to forests, grasslands or the great monocultures—cotton, sugar, etc.—of the tropics. It involves, too, the same or an increasing expenditure every year.

The second method consists in growing crops more or less immune to the attacks of the pest in question. It is carried out either (1) by breeding resistant strains, or (2) by growing the crop only in those soils and situations which strengthen any natural resistance the plant may already possess, or at those seasons when the pest is not virulent. The first has immense possibilities, and is a sound investment for the future; but the plant-breeder in the tropics is beset with many problems, and should not be called upon, save as a last resource, to reject otherwise promising strains which happen to lack resistance to some particular insect attack. The second practice, if carried to an extreme, is virtually an admission of defeat.

The third method of insect control is an extension of the principle of domestication—an increase in the number of our animal auxiliaries. It depends on the fact that all agriculture involves a disturbance of the balance of nature. In the case of crops, one kind of plant, often over huge areas, is encouraged at the expense of all others. It follows logically that the insects which feed on that plant are commensurately encouraged. When, moreover, the plant, as in so many of our colonies, is growing in a country to which it is not indigenous, it is often the case that these insects have accompanied it to its new home. There, under possibly more favourable climatic conditions, and without the natural enemies which kept them in check in the country of origin, they increase beyond all bounds, and constitute pests of the first order. If, now, some of the natural enemies of these insects are introduced and established in the new country, the balance of nature is to that extent restored, and the serious pest may be reduced to negligible proportions. Such in its simplest and strictest form is the principle of biological control. Various attempts have been made to utilize in the same way the bacteria, fungi and protozoa responsible for the diseases of insects. Such diseases seem far more dependent on climatic conditions than do insect parasites and predators, and as such they are far less amenable to human control. No general success has yet been achieved by their use.

Like many other inventions, biological control is not so new after all. The Chinese, as early as the twelfth century, periodically introduced into their orchards the nests of the green tree-ant (*Œcophylla smaragdina*), and even connected the trees with bamboo rods, so that the ants, in their search for the pests on which they preyed, might have access everywhere.

In the Western world the first to envisage the biological control of insects was apparently Bernardin de Saint-Pierre, who wrote in 1784: "It is important for us to be acquainted with at least such insects as destroy those offensive to man. We might take advantage of their hostility, and convert it into the means of our own repose. . . . Man has it in his power to multiply, at pleasure, the families of insects which are useful to him, and he may find the means of diminishing such as commit depredations on his agricultural possessions."

The first actual attempt to put such an idea into practice, however, seems to have been made in 1873, when the mite (*Tyroglyphus phylloxeræ*) was introduced into France to combat the dreaded *Phylloxera*—but with no success.

Since then there have been over forty definite introductions of parasites from one country or region into another, of which about half have so far given beneficial results.

The sweeping success of the Australian ladybird (*Novius cardinalis*) against the cottony cushion scale (*Icerya purchasi*) in California in the eighties of last century, and since then in South Africa, in Egypt and in Europe, led in some quarters to almost unbounded faith in the new method. It is now realized that the matter is almost infinitely more complicated than it then seemed, and that, above all, fundamental research is in every case a prerequisite for success.

Before considering the application of this principle to cotton pests, we may gather something of its status in modern entomological practice from a few of its later successes.

The leafhopper (*Perkinsiella saccharicida*) from Australia reached Hawaii about 1898, became a serious pest of sugar-cane, and by 1904 threatened the industry. Egg-parasites of this insect were introduced by Perkins and Koebele after long searching in Australia, and these began to multiply rapidly by 1906. "In 1907 one very large plantation, owned by the Hawaiian Agricultural Company, whose crop had dropped from 10,954 tons in 1904 to 1,620 tons in 1905, and to 826 tons in 1906, made the next year 11,630 tons almost entirely as the result of the parasite introduction" (Howard). Over a large proportion of the infested areas this control was maintained for a number of years. But outbreaks still occurred in certain districts, and, to prevent their recurrence, Muir in 1920 introduced from Queensland a predacious bug (*Cyrtorhinus mundulus*) which has now completed the control of the cane leafhopper.

By similar methods, involving long and arduous research in the various countries of origin, Muir and his co-workers in Hawaii have now controlled satisfactorily a number of other pests, and have shown that expenditure on biological control is a profitable investment. The work on cane pests in Hawaii has been financed by the planters themselves.

In New Zealand, the woolly aphis (*Eriosoma lanigerum*) was a pest of the first order. A small parasitic wasp, *Aphelinus mali*, was introduced by Tillyard from America, the original home of the aphis, and successfully established. After some four years he was able to state that "woolly aphis is now under satisfactory control in New Zealand and is no longer regarded as a serious pest."

In Fiji, the small Zygænid moth (*Levuana iridescens*), attacking the coconut, became of recent years a pest of the first magnitude. A Tachinid fly parasitizing a not closely allied moth on coconut in Malaya was introduced with great difficulty in 1925. It became established almost at once and attacked the Fijian moth with vigour. In 1927 Tothill, who had directed the campaign, was able to report that the *Levuana* moth could hardly be found save in four isolated spots, and was, for all practical purposes, already controlled.

Biological control of insect pests is now almost universally recognized as a valid principle. The unbounded optimism has gone, but so also has the groundless fear that parasitic insects introduced under expert entomological control might themselves become pests. With the foundation by the Empire Marketing Board of a special laboratory for this work under the Imperial Bureau of Entomology, its rapid further extension throughout the British Empire seems assured. But although the principle is valid, the number of trials has so far been too small, and the complication of biological factors involved too great, for subsidiary principles to be enunciated with any degree of assurance. Almost every attempt has been followed by efforts to explain, in generally applicable terms, either its success or its failure as the case might be. But there are simply not enough data available to enable us to prophesy that biological control will succeed completely or quickly in one case, or not in another. Among the many examples given above of its successful application, there is at least one involving an insect—the woolly aphis—considered by Berlese, only four years before the attempt was made, as a pest almost certainly not amenable to this form of control.

Past triumphs and failures do, however, give us something to work upon. The biggest series of successes have been obtained in certain definite regions which are evidently favourably situated in this regard. New Zealand is undoubtedly one such region, but the most striking instance is afforded by the Hawaiian Islands. In the latter case this is usually attributed largely to some four features:

1. Nearly all the pests are immigrants, accidentally introduced without their own enemies.
2. The indigenous fauna is of a limited and peculiar kind—the product of long isolation—so that the chances of the immigrants finding new enemies in it are very small.
3. The climate is warm and equable, allowing introduced parasites to multiply without seasonal checks.
4. There are only one or two main crops, so that high organization and centralization are possible, and a small improvement is rendered important by the large scale of operations (Fullaway).

Number 2 is especially important. It is above all in islands with a limited and peculiar fauna and flora that new pests and new insects and new weeds are most liable to sweep all before them. The changes wrought by agriculture in such regions usually involve the sweeping away wholesale of indigenous associations, and the restriction of most of the native plants and animals to the hills, leaving free room for the immigrant pest species.

Of these features contributing to success in biological control, New Zealand shows in a marked degree numbers 1 and 2, and to a much less extent 3, while Fiji exhibits 1, 3, 4, and in a smaller degree 2.

It is safe to say that any country possessing these four qualities in some degree is favourably situated for biological control. One would expect that once suitable natural enemies were discovered, imported and established, the task would in most such cases be accomplished. Probably the most unfavourable regions in which to attempt control of this nature lie in continental areas, with a rich and varied fauna, and a " temperate " climate, with a cold winter. In such areas it might be necessary to breed the parasites continuously in the laboratory and distribute them periodically so as to force them into a condition of permanent dominance, to use the term of H. S. Smith. Such is the method used with the Australian ladybird, *Cryptolœmus montrouzieri*, in California, against the citrus mealybug. It is, of course, considerably more expensive than mere introduction and establishment accomplished once and for all; but, at least in the citrus industry, it remains less costly than chemical measures of control.

The extension of this principle of assisting, as it were, the work of parasites already established, may theoretically be extended to indigenous natural enemies of pests either native or imported; but it must be emphasized that such extension has nowhere yet met with any notable success, and biological control as a whole should not be judged by the trial of it alone. The corollary is that the best results in biological control are to be expected in the future, as they have been obtained in the past, from the introduction and establishment of parasites from other regions. And this again implies that the task is not one for the local entomologist to perform single-handed. One so often reads, in the account of a pest, either that natural enemies are not plentiful; *therefore* no help can be expected from them; or natural enemies are plentiful but exert no appreciable control; *therefore*—again—no help can be expected from them. This shows a complete misconception of the whole problem. Every case must, in the present state of our knowledge, be considered on its own merits, by a specialist who can study the pest and its enemies in the different parts of its range.

A most essential part of the work consists in freeing the imported parasite or predatory enemy of its own parasites before it is liberated. Mistakes of this kind are irrevocable, but one of the earliest of all attempts at biological control—the endeavour to combat the imported aphids or plant lice in New Zealand in 1874 by introducing English eleven-spotted ladybirds into the colony, was almost certainly defeated by their liberation without this precaution. Most adult insects can be liberated at once without risk of secondary or hyper-parasites, but beetles are liable to parasitism in the adult stage. These English ladybirds became established in New Zealand; but so also did their hyper-parasite, which has enormously impaired their efficiency to the present day.

The controversy as to the necessity for a *sequence* of parasites, to attack various stages of the pest insect, with the dangerous tendency to the opposite extreme of super- and co-parasitism, or the injurious competition of several parasites for the same individual hosts, seems now to have been resolved in the policy of sending one or two judiciously selected species at the beginning, and observing their effect, before introducing others.

We have seen that the most sweeping series of successes in the history of biological control have been won in the sugar-cane industry. Almost certainly the crop next most favourable for the application of this method is cotton. Like cane, it is often the only plant grown over a wide area; like cane, again, its culture tends to make a clean sweep of the indigenous vegetation and the associated fauna. As with sugar, there is every facility in the cotton industry for organized and centralized research, for inter-colonial co-operation and for commercial enterprise in entomological work. Egypt would seem particularly favourable for biological control. Cultivated Egypt is practically an island—bounded on every side by sea or by its zoogeographical equivalent—desert. Its fauna, if not strikingly peculiar, is very limited. The same remarks may be applied to Mesopotamia.

The Indian, African and Australian cotton-growing areas undoubtedly seem *a priori* less favourably situated for biological control, but the fact that many of the most important cotton pests are introduced insects in the regions where their depredations are most heavy, is, from this point of view, a redeeming feature.

In view of these considerations it may be confidently asserted that the possibilities of the biological method in the control of cotton pests are very great indeed, and the application of such methods would seem particularly promising in Egypt.

In considering such possibilities it should be emphasized that biological control is relatively permanent—not annual—and involves only an initial expenditure, often of negligible amount.*

In the following pages it is proposed to discuss a number of the more important cotton insects from this point of view. Before proceeding I should like to thank Dr. G. A. K. Marshall and Mr. F. Muir for several suggestions which I owe to a discussion of the problem with them, and Dr. S. A. Neave for arranging that I should write this article.

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* The control of woolly aphis by *Aphelinus* in New Zealand, and that of mulberry scale in Italy by *Prospaltella berlesei*, costs the cultivators of these two countries nothing. The Hawaiian sugar-planters spend large sums on entomological research, but regard such expenditure as the most profitable investment.

**The pink bollworm** (*Platyedra gossypiella*).—It seems generally agreed that the home of this now widespread pest is India and Southern Asia generally. I am not aware that any serious research has been undertaken to locate this more exactly; yet this is the region that should be exhaustively searched for efficient natural enemies. So far as our present knowledge indicates, the Punjab is the most promising area in India itself—for Husain and Lal in 1921-1922 definitely stated that there the pink bollworm was not a pest. But since in many other cotton-growing areas of India this insect is a pest of the first order, it is possible that its true home lies in some other part of Southern Asia. Failing these possibilities, a study of the natural enemies should be made in any area where the attacks of the pest seem less virulent. Of such areas, Fiji seems at present the most promising, if only for the reasons that Mr. H. W. Simmonds, Government Entomologist, has recently reared from the pink bollworm an apparently unrecorded pupal parasite of the genus *Chalcis* (*Brachymeria*).

The list of known parasites and predators on the pink bollworm is a formidable one; but it includes a number of merely incidental cases of attack by indigenous insects in the various regions to which the bollworm has gained access.

In India itself parasitic enemies of the pink bollworm are recorded as very scarce. Whether this scarcity is due to hyper-parasitism, which might be avoided after introduction of the parasites into a new country, could be profitably investigated. The parasitic enemies at present known in India include a Bethylid (*Perisierola* sp.), possibly four Braconids (*Apanteles* sp., *Chelonella* sp., *Bracon* sp., and *Microbracon lefroyi*) of which the last is a more regular parasite of the Indian bollworms (*Earias* spp.), and finally perhaps two Chalcidids (Ramakrishna Ayyar, Ballard, Husain). Most of these species have not yet been properly identified, and in fact have usually been observed only incidentally when studying the Indian bollworms (*Earias*). Burt records (1918) an unknown parasite attacking upwards of 20 per cent. of the pink bollworm in the United Provinces. Predatory enemies include the Anthocorid bug (*Triphleps tantilus*) and an undetermined Reduviid nymph (?) observed by Ballard. In view of Muir's utilization of a Capsid bug (*Cyrtorhinus*) against the leaf-hopper in Hawaii, the possibilities of *Triphleps* should be investigated.

In Egypt much more special attention has been paid to parasitism of the pink bollworm. The chief parasite seems to be the native Ichneumonid, *Pimpla roborator*, which, in possessing a very long ovipositor, seems well fitted to reach deeply hidden larvæ of the pest. Its suitability for introduction into other countries is, however, very doubtful. Not only is it a general parasite of lepidopterous and other larvæ, but Seyrig (1927) has lately made the interesting observation that it is at times a hyper-parasite attacking another Ichneumonid of the same genus (*Pimpla malacosomæ*), in which activity it is, of course, definitely injurious. Nothing indicates better than this the vital necessity of the most searching investigation into the habits of any parasite it is desired to use. Other parasites in Egypt include two Chalcidid wasps (*Pteromalus* spp.), two Braconids (*Microbracon kitcheneri* and *Chelonella sulcata*), an Ichneumonid (*Limnerium interruptum*), a Bethylid, and the mite *Pediculoides ventricosus*. Among predators are *Triphleps* sp. again, and the larvæ of the common lacewing fly (*Chrysopa vulgaris*).

In Italian Somaliland Del Guercio (1918) discovered no fewer than five unidentified parasitic wasps attacking the pink bollworm. Of these three were Chalcidids (one affecting the eggs, and two others the larvæ), a Braconid and a Proctrotrupid.

In Kenya Colony and in Tanganyika Kirkpatrick and Ritchie have found another Braconid (*Microbracon kirkpatricki*) in the latter region attacking pink bollworm only when infesting okra (*Hibiscus esculentus*). An unidentified Chalcidid is also recorded. In Kenya it would seem to be extremely promising—destroying up to 76 per cent. of the pest.

In Uganda the true pink bollworm seems not to occur, but an extremely closely allied form (*Platyedra erebodoxa*) infesting a wild plant (*Hibiscus diversifolius*) was found by Hancock to be parasitized by no fewer than three Braconids, which are not yet identified.

Turning now to the New World, reached by the pink bollworm about 1911, we find one of its enemies, the widespread mite *Pediculoides ventricosus*, already waiting to attack it—at least in the West Indies, Mexico and Brazil. It is probably not practicable to augment artificially the services of this natural enemy, nor would it be advisable in view of the skin affection it produces on the arms of cotton workers when abundant. In Mexico, Ohlendorf, Townsend, Loftin and other workers have published a fairly formidable list of other pink bollworm parasites, which include one Chalcidid (*Trichogramma minutum*) living in the egg, two or three Braconids, a Bethylid (*Perisierola emigrata*), and, most interesting of all, a Tachinid fly (*Tortriciophaga* *tortricis*) attacking the larvæ. The Tachinid, according to Townsend, was sometimes in considerable abundance. The *Trichogramma* and the two Braconids have a number of other hosts. Loftin and his co-workers reported also a very high mortality due to the nymphs and adults of three species of heteropterous predators.

The parasites of the pink bollworm reported in Brazil (by da Costa Lima and by Guenther) comprise a Bethylid (*Perisierola nigrifemur*), two Chalcidids (*Trigonura annulipes, Encyrtaspis proximus*), two Braconids (*Urogaster balthazari, Bracon vulpinus*) and an Ichneumonid (*Scambus* sp.). Ants of two genera and a few birds also attack the larvæ.

With the Hawaiian Islands our survey of the natural enemies of the pink bollworm closes, though the very nearly allied Queensland bollworm (*Platyedra scutigera*) is attacked by a species of *Microbracon*. The Hawaiian parasites have recently been studied in considerable detail by Willard (1927). Earlier records were due to Fullaway, Swezey and Busck. Willard considers the most effective parasite under Hawaiian conditions to be the Braconid wasp (*Microbracon mellitor*), which attacks it also in Mexico. Neither this nor any of the six other species is a specific parasite of the pink bollworm. The latter include the Braconid *Chelonus blackburni*; the Ichneumonids *Pimpla hawaiiensis, Pristomerus hawaiiensis*; the Chalcidids *Chalcis obscurata, Stomatoceras pertorvus*; and the Bethylid *Perisierola emigrata,* already noted from Mexico. It is interesting that *Chalcis obscurata* was originally introduced from Japan for a different purpose. Following the usual habit of these species, *Microbracon* and *Perisierola* attack the larvæ, while the other species emerge from the host pupa.

A regional analysis of the above data regarding natural enemies of the pink bollworm reveals a most interesting state of affairs. Considering those types of parasites and predators which are likely to be of most value in entomological practice, we find that larval parasites of the genera *Microbracon* or related forms, and *Perisierola* or related forms, attack the pink bollworm in almost every area from which it is reported. The little wasps of the former genus parasitize very many species of hidden moth and beetle larvæ, and paralyze (thus eventually killing) for their own food-supply far more prey than they need for egg-laying. Research is needed into the probable existence of biological races confined to different hosts. In the immediate future it is probable that neither these nor the Bethylids, already widespread as they are, could be materially assisted in their effects on bollworm infestation.

By some an egg-parasite has been hailed as the great desideratum.

One or more forms exist already in Egypt, Italian Somaliland, Mexico and Brazil, but we know extremely little about them. Further study would doubtless be profitable here.

Pimpline *Ichneumonidæ*, by reason of the often very long ovipositor, always seem promising parasites. They are also, if one may generalize, very easy to rear. Species attacking, even incidentally, the pink bollworm, are at present known only in Egypt, Brazil and Hawaii, and we have given good grounds for rejecting the services of the Egyptian species.

The species of the genus *Chalcis* and its relatives are often efficient parasites. On the pink bollworm they occur in Fiji, Hawaii and Brazil.

A Tachinid parasite has been recorded from Mexico only, but there abundantly in at least one district.

Small predacious heteropterous bugs suck the eggs and young larvæ in India, Egypt and Brazil. Further study may prove them quite promising.

It will be remarked that only two important kinds of pink bollworm parasites are absent from the cotton-growing areas of Egypt—namely, wasps of the genus *Chalcis* (*Brachymeria*) and Tachinid flies. Both are exceedingly promising, and one would have no hesitation in recommending, as an immediate measure looking towards biological control, the introduction, after preliminary study, of insects belonging to one or both of these groups.

**Other Bollworms.**—The moths of the genus *Earias* are serious pests of cotton throughout India and Africa, including Egypt, and they occur also in Australia. A number of separate species are involved, which are usually indigenous in the areas concerned, thus presenting quite a different problem from that of the pink bollworm, and one less amenable to solution on the principle of biological control. The most noteworthy parasites at present known are species of *Microbracon*. Attempts were made for a number of years in India to augment their work by artificial means, but conclusive evidence of improvement seems lacking. Lefroy was responsible for the theory that the first great outbreak of *Earias insulana* in 1905 in the Punjab was due to the unusual cold of the previous winter, which affected adversely the parasites' more than their hosts. Thereafter it became the practice at Pusa, under Fletcher, to collect large quantities of parasitized material (chiefly *Microbracon lefroyi*) and send it every season to the Punjab. The Egyptian Government also introduced this species into Egypt against *Earias insulana* there, but the first attempt at establishment was apparently not successful, and the project was abandoned on the discovery of a similar parasite (*Microbracon kitcheneri*) already in the country.

Some thirteen different parasites of these bollworms (*Earias* spp.) have been recorded from India (Fletcher, Husain and Mathur, Bhasin, M. M. Lal, Misra). These include a polyphagous *Trichogramma* parasitizing the eggs, five Chalcidids (one attacking the larvæ, and four the pupæ), four Braconids (three larval and one pupal parasite) and a Tachinid fly (*Actia ægyptia*).

In Egypt, besides *Microbracon kitcheneri* (present also in Iraq), there is a Chalcidid parasite (*Chalcis brevicornis*).

Natural enemies of *Earias* bollworms in other parts of Africa include an Ichneumonid wasp (*Paniscus parvulus*) and a Braconid (*Microbracon ?*) in Nyasaland, where also Mason records a high percentage of parasitism by five species of Tachinid flies, which are themselves heavily attacked by numerous hyper-parasites. An unidentified parasitic wasp occurs in Uganda, and two Braconids in Southern Nigeria, while predatory enemies include three Pentatomid bugs in Nyasaland, and the Eumenid wasp (*Rhynchium ventrale*) in Nigeria.

In the Northern Territory of Australia are the Chalcid (*Bephratella sarcophaga*) and three other Hymenopterous parasites.

What are the possibilities of controlling *Earias* in any part of its range by the utilization of natural enemies? In the first place, further study doubtless would bring to light other parasites; and, in the second place, there is considerable promise in a distribution of parasites from one region to another, on a larger scale than has yet been attempted. What, for example, might not be the effect of the five Nyasaland Tachinid flies could they be established in Egypt without the hyper-parasites which so seriously impair their efficiency in their native home?

The American bollworm (*Chloridea obsoleta*) occurs throughout the tropics and subtropics of both hemispheres and attacks a variety of crops. On cotton its depredations are extensive chiefly in South Russia, North America, South Africa and Australia. "It is extensively and effectively parasitized, and on this account its occurrence is sporadic" (Ballou). An attempt has been made in Sumatra to reduce its numbers by the breeding and distribution of the Chalcidid egg-parasite *Trichogramma*. Egg-parasites of this genus are already very widely distributed, and are largely indiscriminate in their selection of hosts, though Marchal's recent work shows the possible existence of numerous "biological species" attached to distinct hosts. Da Costa Lima is responsible for the statement that this bollworm (*C. obsoleta*) is not a serious pest in Brazil. It might be profitable to search there for a new parasitic enemy.

The African or red bollworm (*Diparopsis castanea*) is confined to the West, South and East African and Sudan cotton areas, where it constitutes a widespread and serious pest. In Nyasaland, according to King (1926), natural control disposes of some 99 per cent. of the infestation; so that a thorough study of its parasitism there would probably be profitable for other areas.

Some score of other moth larvæ are recognized as pests of cotton in various parts of the world—as "bollworms," "leafworms" and so on. A full list of their natural enemies has been compiled, but space will not allow their discussion here.

**The boll weevil** (*Anthonomus grandis*) is confined to America, where both as growing larva and adult it inflicts almost incredible damage on the cotton crop. It has been the object of very intensive study by the United States Federal and State entomologists, who have discovered no fewer than fifty-four different species of insects parasitic or predacious upon its various stages. But the fact that the insect is hidden within the square, from the laying of the eggs right through the life-history till the emergence of the adult, gives it a great advantage over its natural enemies. These, both predatory and parasitic together, are calculated to destroy no more than about 20 per cent. (Hinds). No means of augmenting their efficiency seem to have been devised. It is possible that a parasite or predator on the related weevils of wild cottons in Central America or the north of South America will one day be found sufficiently promising to warrant its introduction, though, so far, attempts have met with no appreciable success.

In Peru, in East Africa, in Sudan, in India and elsewhere a number of other weevils have become more or less serious pests of cotton. A list of their natural enemies, so far as recorded, has been compiled, and the possibilities of biological control seem worth considering. Already Surcouf (1927) reports great success in the control of an East African cotton weevil (*Apion armipes*) by the breeding and judicious liberation of a Braconid parasite; while Johnson (1926) considers the small parasitic wasp *Lathromeris johnstoni* "a very valuable agent in the control of the cotton stem borer" (*Sphenoptera* sp.) in the Sudan.

Of all the pests of the cotton plant, the **stainers** (*Dysdercus* spp., *Oxycarenus* spp., *Tectocoris lineola* and others) have been signalized by Professor Ballou as the most likely to affect the development of cotton-growing in new localities. Not only does their sucking itself cause certain direct injury; but they are also implicated in the transmission of serious internal boll rots. Yet the stainers are precisely the insects which have been the least studied of all cotton pests, from the viewpoint of biological control. The true cotton-stainers (*Dysdercus* spp.) are among the most familiar insects of the tropics. Their usually brilliant red coloration—especially in the younger stages—has earned them one of their vernacular names, and has led to the widespread belief—the evidence for which I have analyzed elsewhere (1927)—that they afford instances of "warning coloration," and are thus largely free from the attacks of natural enemies.

Nevertheless, a number of interesting natural enemies of *Dysdercus* do occur. Of wide occurrence in Africa, various predatory bugs of the genus *Phonoctonus* (*P. fasciatus*, *P. nigrofasciatus*, *P. picturatus*, *P. formosus*, *P. principalis*) seem especially to hunt cotton-stainers, which, curiously enough, they often extremely closely resemble in appearance, though widely separated in the classificatory system. All stages, from young nymphs to adults, of the stainers are attacked (Pomeroy and Golding, Ghesquière, Mason, Morstatt, Zacher, etc.).

In Southern Nigeria, Pomeroy and Golding have studied the parasitism of *Dysdercus* by five different kinds of Tachinid flies, which deposit their eggs usually on the abdomen of the adult host. In some cases as many as 20 per cent. of the most destructive species of stainer were thus affected. Although it seems that these flies shorten the life of the host to a considerable extent and frequently prevent oviposition, the authors do not consider them of real economic importance under present conditions. The possibility of introducing these parasites into other cotton areas where they do not occur has apparently not hitherto been visualized; but it decidedly merits serious consideration.

Other Tachinid parasites of *Dysdercus* have been recorded from Peru (two species, Townsend), from Trinidad (*Trichopoda* sp., Urich), from Northern Australia (Hill), and from Queensland (Ballard).

The eggs of *Dysdercus sidæ* in Queensland are reported by Ballard to be heavily parasitized (1925). Although this at present unidentified parasite seems to effect no appreciable control under local conditions, it is worth study from the viewpoint of possible utilization elsewhere.

We know, then, three main types of utilizable natural enemies of *Dysdercus*—predacious bugs (*Phonoctonus*) attacking nearly all stages, Tachinid flies parasitizing the adults, and a minute hymenopterous parasite destroying the eggs. Furthermore we have the testimony of Ritchie (1925) that he has not seen, in Africa, mass infestation of *Dysdercus* like those he was familiar with in the West Indies. Is it not significant that it is in Africa that the numerous species of *Phonoctonus* are widespread, and at least five parasitic Tachinid flies occur, while in the West Indies, on the other hand, we have the evidence of Ballou, myself and other observers, that natural enemies other than lizards are extremely rare ?

**The green plant-bug** (*Nezara viridula*), a very widely distributed pest of cotton and other plants, is well controlled in St. Vincent by egg-parasites, and heavily parasitized in Florida and other Southern States by Tachinid flies (Drake, Jones). A study of these parasites might well be made with a view to their introduction into regions where the green plant-bug is a much more serious pest.

The Egyptian cotton seed bug (*Oxycarenus hyalinipennis*) is said by Kirkpatrick to be entirely free from insect parasites. Bugs of this genus are well known in other parts of the tropics, where intensive study might reveal promising parasites.

As regards the possibility of controlling the cotton **jassid** (*Chlorita* [*Empoasca*] *facialis*) by biological methods, it seems that no investigations have yet been made on its insect enemies, notwithstanding the fact that one of the greatest of all triumphs of biological control was won against a leafhopper (*Perkinsiella*), though admittedly one of a very different family. Vayssière and Mimeur (1925) record the rare occurrence of a predatory enemy of the cotton jassid in the form a Hemerobiid larva in French West Africa; but some of the very numerous parasites of Typhlocybid leafhoppers in other parts of the world would seem to offer much more promising means of control.

The immediate desideratum in attacking this problem would be a region climatically fairly similar to that of the Rhodesian and South African cotton fields, and one in which jassids of the same genus (*Empoasca* or *Chlorita*) are living on cotton or some other malvaceous plant, but are kept in check apparently by natural enemies. Existing information on this point is insufficient to obviate the necessity for a search, and for this purpose Mexico would appear unquestionably to commend itself as offering the most favourable possibilities for success. Possibly also there is a chance that Ballard's jassid in Queensland, which was a pest on certain soils only, was kept down in other areas by the agency of natural enemies, and not directly by soil factors. Once such an area of natural control was found, further study in the field by a specialist in parasite work would indicate which were the most promising parasites to introduce into South Africa.

It has long been recognized that **scale-insects** (*Coccidæ*) are peculiarly easily combated by the utilization of parasitic and predacious enemies. Townsend in 1913 reported on a campaign waged in this way against the *piojo blanco* or white scale (*Hemichionaspis minor*) of cotton in Peru. Later information as to the outcome seems lacking.

Among the cotton pests which are, at the present day, held very largely in check by the agency of natural enemies is the **cotton aphis** (*Aphis gossypii*). Although this often becomes a serious pest, it is usually cleared off in a remarkable manner towards the end of the season by the combined action of parasitic Hymenoptera (*Aphidius, Lysiphlebus*, etc.), Diptera and predacious ladybirds (*Coccinellidæ*), Syrphid flies and lacewing flies (*Chrysopidæ*). This periodic checking has been recorded in Australia (Ballard, Gurney), Africa (Cotterell, Hargreaves, Lamborn, Mason, Peacock, Ritchie, Vayssière and Mimeur, Gowdey), Russian Central Asia (Vassiliev), North America and West Indies (Skeete, Paddock, Morrill, Wolcott, Smyth). No doubt the attack could be checked at a much earlier stage by the insectary breeding of large numbers of a suitable predator, preferably a ladybird beetle (*Coccinellid*) and its liberation at the critical moment. Great success has attended this method of rearing the ladybird *Cryptolæmus* against citrus mealybug in California (H. S. Smith).

Space will not permit the discussion of the natural enemies known to attack a number of other more or less serious pests of cotton, but a card index of all these has been compiled, and is available as a basis for future research.

To sum up, biological control, where applicable, is the most economical method of plant defence against insect attack. It possesses the added advantage of relative permanence.

The possibilities of its application in the cotton-growing industry are in many cases very promising. These possibilities should be considered along two lines:

1. The feasibility of augmenting the efficiency of natural enemies already present in a given region.
2. The more promising possibility of an interchange of parasites between different cotton-growing countries.

Egypt is ecologically an island, and lacks a number of important cotton-pest enemies found elsewhere. After the necessary preliminary research and judicious selection, some of these might profitably be imported.

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# THE CONTROL OF COTTON STAINERS IN SOUTHERN NIGERIA

BY

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For more than twenty years efforts made to introduce American cotton into the Southern Provinces of Nigeria proved abortive, probably on account of severe infestation by insect and fungus pests. The principal factors inhibiting the development of exotic cotton were undoubtedly the Cotton Stainers, *Dysdercus* spp., and the fungus, *Nematospora* sp., which is introduced into the green bolls by stainers, *vide* Nowell ([7] 1923), Mason and Jones ([6] 1924), Laycock ([3] 1925).

In 1924 a method was devised of determining stainer infestation on similar areas of exotic and indigenous cotton; it was found that there were over five times more stainers on American cotton than on the indigenous species, *Gossypium peruvianum,* between October and the middle of January. In the succeeding year similar results were obtained, and American cotton was abandoned in favour of strains of an indigenous cotton, *G. vitifolium,* bred out by Lewin ([5] 1927). These strains are superior to the American variety in lint qualities, and it is hoped that they will ultimately provide the Southern Nigerian farmer with a lucrative cotton crop. At the time of writing the improved strains are undergoing their first large scale test, and it remains to be seen whether they are suitable for mixed cropping—a common practice in Southern Nigerian agriculture.

Although indigenous cotton is not subject to the extremely heavy stainer infestation experienced by the American variety, analyses of the damage caused by various insect and fungoid factors have demonstrated that stainers (in conjunction with *Nematospora*) are also the most serious pests of *G. vitifolium* ([2] 1927).

The scope of the present paper is to give an account of the control methods against stainers which have been investigated and found wanting, and to describe the lines of research now being followed which, in the opinion of the writer, may well lead to the solution of the stainer problem of the Southern Provinces of Nigeria.

## I.—ABANDONED CONTROL METHODS.

(*a*) *Parasites and Predators.*—In 1922 a thorough investigation was made of the life-histories of the various species of stainers, the most important results being the discovery of four species of parasitic flies—all new to science—and of three species of mimetic predaceous bugs ([9] 1923).

Unfortunately it was found that the longevity of stainers containing larvæ of the parasitic flies was not markedly less than that of unaffected individuals, and that a considerable proportion of parasitized female stainers were able to oviposit. The explanation of the small effect of the presence of parasites upon their hosts is that the larvæ feed on the fatty tissue in the thoracic region and do not interfere with the vital organs of their hosts. Further, the flies almost always attach their eggs to adult stainers, probably because eggs adhering to the bodies of immature stainers would be discarded with the " skins " after moulting had taken place.

It was hoped that the predatory bugs would prove to be a more efficient control, as they preyed upon adults and nymphs indiscriminately, their attack resulting in the instant death of the prey. During a life which, in some cases, was found to exceed five months, an adult predator was discovered to kill, on an average, three stainers a day. In the course of systematic picking of stainers in 1924, the children employed for collecting were unable to differentiate between stainers and mimetic predators; the latter were liberated by the writer from the collecting boxes at the termination of stainer-picking. In this way it was found that predators were entirely absent after the middle of November, presumably on account of the increase in atmospheric aridity which occurs at that time of the year.

Similarly, evidence was obtained of a decrease in the activity of parasitic flies, the proportion of adult stainers bearing parasites' eggs falling from 15·5 per cent. in September to 0·9 per cent. in December.

It will be seen that although both parasites and predators play an important part in reducing the numbers of stainers, there is little hope of either becoming an effective control.

With regard to the possibility of introducing parasites from other countries, few natural enemies of stainers are known elsewhere, and in no part of the world do they control *Dysdercus* effectively.

(*b*) *Close Season Measures.*—The object of such measures is to deprive the stainer of the plants on which it feeds when cotton bolls are not available. In Southern Nigeria this period is, theoretically, between the end of March and the middle of September; but, in practice, many of the farmers fail to uproot their cotton at the end of the season. Thus cotton itself must be added to the list of plants which have to be eradicated in the close season period. The principal alternative food plants of stainers in the Ibadan district, where it was decided to test close season measures experimentally, are Silk Cotton trees, cultivated Okras, and a number of malvaceous weeds.

In 1923 an area of nine square miles (three miles by three) was selected, having as its centre Moor Plantation, the headquarters of the Agricultural Department; the plantation is somewhat less than one square mile in area. All Silk Cotton trees (about 350 in number) in the area were felled by contractors in April, the felling being decidedly costly on account of the enormous girth of many of the trees; and the writer, accompanied by a posse of Native Administration police, traversed the entire area in search of standing cotton and fields of Okra. The farmers were instructed to uproot both crops, and were generously compensated for the loss of their Okra.

Similar operations with regard to cotton and Okra were repeated in 1924, with the exception that the farmers had been warned previously not to plant Okra between March and the end of July. Nevertheless, Okra fields were found in the area, and again the farmers had neglected to uproot their cotton at the end of the season, except when the land was required for the planting of another crop. By the end of April both crops had been eradicated, and, except for one or two defects such as the discovery in early June of a large dump of waste cottonseed in the midst of grass over six feet in height, the close season measures of 1924 may be considered to have been effectively carried out.

In 1925 the operations were repeated and the effect of the close season measures was tested by determining stainer incidence on two identical 5-acre plots of cotton, one in the centre of the area, and the other about three miles west of its boundary (² 1927). Three species of cotton were grown in each plot, and in the following table is shown the number of stainer adults collected on ⅛ acre of each species in the two localities in twenty weekly pickings.

| | *Number of Adult Stainers on :* | |
|---|---|---|
| *Species of Cotton.* | *Plot in Close Season Area.* | *Plot 3 Miles West of Boundary of Close Season Area.* |
| *G. hirsutum* .. .. | 8,855 | 1,211 |
| *G. peruvianum* .. | 4,932 | 359 |
| *G. vitifolium* .. .. | 3,692 | 540 |

It will be seen that the results were, to say the least, discouraging; the measures were undoubtedly ineffective.

Flight experiments, in which marked stainers were released at distances of one mile and half a mile from the plantation boundary, demonstrated that *Dysdercus* is capable of flying one mile in less than eighteen hours, and at no point was the periphery of the Close Season Area more than one and a half miles from that of Moor Plantation. It is obvious that the area of nine square miles was too small to effect an efficient isolation of Moor Plantation; but the difficulties encountered in eradicating a very common tree and a native food crop from this small area were so pronounced that the application of close season measures on a large scale in Southern Nigeria is out of the question. To ensure the efficiency of the measures it was necessary for the writer to traverse every bush-path in the nine square miles, a task which involved walking between two and three hundred miles, and required six weeks to accomplish.

Disregarding the important question of expenditure altogether, it is obvious that similar measures on a large scale would have to be supervised by Africans, and it is certain that the degree of efficiency attained in the experimental area would not be approached. In addition, there are a number of widely distributed malvaceous weeds on which stainers can subsist, and the eradication of these plants in Southern Nigeria would be an immense undertaking.

Although extensive close season measures are so obviously impracticable, the writer is inclined to think that the enforcement of existing legislation with regard to the uprooting of cotton at the end of the season is desirable, chiefly with the object of exposing bollworm pupæ in the soil.

With reference to the utilization of close season measures in Southern Nigeria, the author of a previous article in this journal ([8] 1926) made the following statement: "I suggest, however, that such basic measures as have been tried and found effective in other cotton-growing countries will probably be found applicable." Presumably this writer is referring to the island of St. Vincent, which has an area of about 150 square miles as compared to the 15,150 square miles of the Oyo Province alone. Apart from the disparity in size between St. Vincent and the cotton-growing areas of Southern Nigeria, the question of insularity merits some attention. There are indications that stainers migrate in a southerly direction in Nigeria during the months of October, November, and December, the migration apparently being induced by atmospheric aridity concomitant with the northerly "harmattan" wind. This might well vitiate the effects of close season measures in the Southern Provinces.

(*c*) *Control by Use of Poisons.*—As stainers are sucking insects the spraying of cotton bolls with stomach poisons is useless; contact poisons would probably only be efficacious against young nymphs. Further, it must be remembered that the bulk of Nigerian farmers are uneducated, and, therefore, the use of poisons on a large scale would be fraught with danger. It occurred to the writer, in 1923, that it might be possible to prepare a poison bait by impregnating cottonseed with a soluble poison. Sodium arsenite was utilized for this purpose on account of its solubility in water, and laboratory tests showed that stainers fed readily on the bait and died, in the majority of cases, in less than two and a half hours after feeding. Unfortunately there has been no opportunity to test the poison bait on a field scale; but, even if this method proved to be efficacious, the writer would hesitate to recommend the wholesale distribution of poisoned seed to farmers in this country. The method might be of use in cotton-growing countries farmed by Europeans.

## II.—PRESENT LINES OF RESEARCH.

In five localities it has been found that the migration of stainers to July-sown cotton commences at the end of September, reaches its maximum between mid-October and mid-November (according to the locality), and practically ceases at the end of November when there is an increase in atmospheric aridity. It seemed probable to the writer (1 1925) that September-sown cotton would not be subjected to heavy infestation by stainers as aridity during the flowering period would inhibit migration, but unfortunately field tests have shown that late-sown cotton gives poor yields. Lean (4 1927) has since found that a July-sown indigenous cotton, known as "Kabba," did not produce its crop until late in the season and avoided heavy stainer infestation on account of its late-flowering habit.

In addition, Lewin (5 1927) has bred out two improved strains of *vitifolium* (sown in early July) which produce their crop late in the season. At the time of writing, comparative observations are being made on the degree and time of flower production characterizing these cottons, and on the extent of stainer infestation on both strains. It is hoped that these late-flowering strains of high-quality indigenous cotton will prove to be the key to the solution of the cotton stainer problem of the Southern Provinces of Nigeria.

It seems probable that the only control methods likely to be efficacious against stainers in Southern Nigeria and other African countries are those resulting from plant-breeding. The most hopeful line of research appears to be the production of a strain which produces its crop at a time when stainers are not numerous; in this country, and probably generally, this would entail the breeding of a late—rather than of an early—cropping cotton, as stainers diminish in numbers in the latter part of the season as a result of increased atmospheric aridity.

Another possibility is the production of a strain unattractive to stainers; that will, it is hoped, be investigated in the near future.

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# NOTES ON CLOTHING, CLOTH, AND COTTON IN THE LOWER NIGER

BY

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## I. Clothing.

Two lasting impressions are made on the memory of every European who sets foot for the first time on African soil in one of the West Coast ports. First. there is the steamy heat which takes the starch out of everything, and (closely associated with this) the hothouse smell of the earth mingled with that of perspiring human beings. The second is the bewildering variety of dress, and more striking lack of dress, of the African negro people as they pass in seemingly endless procession, talking, laughing, singing, and carrying on their heads their contribution to the all-absorbing market, which seems to combine the functions of Covent Garden, Farringdon Street, and Billingsgate with those of a daily paper, a club, and a recreation ground.

It is one aspect of the second impression—viz., that of dress, and of that which goes to make it—which is dealt with here.

For the first time, our hypothetical European realizes on his arrival that he has come to a country where clothes are not regarded so much as a necessity of life as that which ministers to the innate vanity of human nature. Climatic conditions in Europe, at any rate for the greater part of the year, do not encourage any out-of-doors display of this side of our nature, except on state occasions, and it can only be indulged in with any satisfaction within the heated chambers of public assemblies.

Experience proves that it is entirely fallacious to associate standards of morality with the degree of clothing adopted, as if those people of Africa where clothing has apparently always been the rule, and who admittedly belong to a higher culture, were therefore higher morally than an unclothed primitive tribe. If all the facts were known, the balance might be in favour of the primitive tribe.

It may help towards a sympathetic understanding of a difficult and thorny subject to sketch a few of the main types of African dress which may be seen in any of the British West African Colonies and Protectorates. It should be said at once that the point of view of the writer is that of one who lived and worked for many years among the Ibo people, one of the largest and possibly most virile of the pagan tribes in the whole of Nigeria. They number close on four million, live chiefly in the eastern area of the Lower Niger, and so far have not been influenced by Mohammedanism.

1. The "*tobe*"—a large square gown of country cloth in plain white or blue, or striped. Wide sleeve-like openings are left for the arms, and the upper part of these sleeves may be thrown over the shoulders to give free play to the arms. An oval opening in the centre is left for the head, and elaborate and beautiful embroideries in colours are often worked on the breast and neck.

"Tobes" usually come below the knee, and are often as low as the ankles, and they are worn with very baggy knickers. A turban completes the dress, which, rightly or wrongly, is generally regarded as Mohammedan in character, as it is in general use by Mohammedans in the Northern Provinces of Nigeria.

In the non-Moslem areas of the Southern Provinces, the "tobe" is gradually being adopted by those chiefs who have been given a warrant by the Government, or by those—and they are many—who aspire to that honour. An uninstructed observer, after a visit to a native court in session, might well be excused the conclusion that the progress of Islam, judged by the dress of the chiefs, was rapid in the south. The reason for the adoption of the "tobe" by chiefs obviously is that it adds dignity to its wearers and serves to impress their people. who have never known the autocratic rule of a single chief. It is not likely that this dress will spread to the people, as it is comparatively expensive, not suitable for manual labour, and is apt to pick up the dirt. Possibly a simple adaptation of the "tobe" worn with a loin-cloth might become general as a dress for special occasions.

2. A long garment, like a cassock, with long or short sleeves with no buttons, and a V-shaped opening at the neck. The material may be cotton, wool, or even silk. It is worn with short knickers or a loin-cloth. This type of garment is to be seen in North Africa, Egypt, and Uganda, and possibly in many other parts of Africa.

3. A loose "*jumper*" of white or coloured cotton cloth, either with or without short sleeves, and worn with knickers or loin-cloth, is by far the most popular type of dress in the southern provinces. and there must be very few native markets where "jumpers" cannot be bought. Usually men are to be found in the markets making them

with sewing-machines, in little leaf or grass covered stalls, decorated with " jumpers " of all colours, each suspended by a string attached to a stick thrust through the extended arms.

4. A *shirt* after the European model, but much longer, and worn over a loin-cloth. This type of garment is peculiar to the Niger Delta and neighbouring districts. The material of such shirts may be of cotton, wool, and even of silk and satin, costing several pounds. They are worn usually with the neck left open and the sleeves unbuttoned, and over the loin-cloth, which is allowed to hang in such a way that one corner in front almost touches the ground. This is an instance of the adaptation of a distinctly European garment in accordance with African ideas.

5. The *loin-cloth*, either alone or in combination with upper garments, is worn by both men and women in many districts in the Southern Provinces. It may be just a strip of country or imported cotton cloth from 15 to 20 inches wide, wrapped round the waist and secured by folding over the top corner of one end and neatly tucking it in. Or it may be a much more elaborate garment, made of several pieces of cloth sewn together and folded into long pleats, one corner being allowed to fall over the left foot, or otherwise, as the fashion for young men may dictate.

A white cotton singlet or vest, or ordinary shirt, worn with a loin-cloth secured by a belt, at one time was the recognized uniform for " boys," stewards, cooks, and cooks' mates, and there is much to be said in its favour.

In the cotton-growing areas " cover " cloths, or large shawls of white or coloured country cloth, are worn with a loin-cloth. Such cloths are thrown around the shoulders, or over one only, and they make up a dress both useful and becoming.

In the Asaba-Benin area the women value most of all a white " cover " cloth with an open-work pattern woven into it, which shows up well on a dark skin.

It comes almost as a shock to learn that painting the body and the wearing of ornaments, such as anklets, bracelets, necklaces, and hairdressing are placed by primitive West Africans in the category of dress. But so it is, and undoubtedly they are right, for an artistic design executed in a shade of dark blue or black, deeper than that of the skin, relieves the sense of nakedness and produces almost the same effect upon the eye as clothing.

The above-mentioned types of native dress show some sort of evolution or adaptation from the simple to the less simple, on what might fairly be called African lines.

Unfortunately, from very early days Europe has been unloading its surplus supplies of old uniforms, second-hand frock-coats, and every variety of clothing, upon the West African market. Before the war the factories or agencies of European firms disposed of enormous stocks of such clothing at very low prices. In one Ibo town known to the writer black frock-coats, some of them with silk or satin facings, worn over bare skin, with loin-cloths, and completed by large black wideawake hats with flapping brims, were the approved fashion for all the old chiefs who could afford to buy them.

The following notes were made by the writer from personal observation in an interior Ibo town many miles from a trading factory:

Here is a man with a long dark blue ulster, open in front, revealing a white cotton singlet or vest and pants. On his head is a policeman's helmet from which flutter two long streamers of black ribbon. His somewhat ferocious face, with its bushy black beard, is set off by a long German pipe with a metal cover. He struts about with bare feet, saying, "Mawning, mawning, tank you," and when he is addressed in his own language, he replies, "Yes," and this is the extent of his knowledge of English.

Yonder is a man resplendent in a scarlet tunic of the Buffs, with white drill trousers, white felt hat, and brown boots. Following close after him is a dandy who is making a tremendous impression. His costume consists of a magenta-coloured satin shirt, with the tail down to his calves, and almost concealing his parti-coloured loin-cloth. An old straw hat is on his head, and he has bare feet.

Then in procession come some venerable chiefs, with grey beards trained to a point in a wisp of hair. Each has on a black frock-coat; some, with a silk facing, look almost new, while others are green with age, and look as if mustard and cress would grow on them without much trouble. On their heads are blue and white striped woollen stockinette football caps, every tasselled point containing the inevitable snuff box or bottle, without which no old man walks abroad, a few kola nuts, and generally a few cowries. Round their waists are loin-cloths coming to below their knees, and their ankles are encircled with two or three ochre-coloured twisted threads of cotton denoting their rank as chiefs. They carry iron staffs or spears with pointed butt-ends which enable them to be planted firmly in the ground. Some are ornamented with narrow bands of brass, and are opened out at the top into what may have been suggested by an old-fashioned gun rest, the shape of the letter U. Bags made of whole goatskins hang from their shoulders, each containing a calabash cup or horn for drinking palm wine and " medicine " to keep away sickness, and little brass or iron bells tied on to the bags accompany, not unpleasantly, every footstep.

Here are some young men rejoicing in thick blue woollen football jerseys, which they have rolled up to just below their chests to allow the air to cool their bodies, and others are wearing some which have shrunk so much that there is no need to roll them up. Each wears round his loins a brightly coloured checked " Madras " cloth covering one hip, and draped to just below the other at what is considered a rakish angle.

Several young men appear armed with English carter's whips, which they swish with great glee as they run about; and these are followed by others clad in scarlet, green, and yellow cloths, carrying coloured umbrellas, and forming an escort for an accordion player. A few men appear in flowing gowns of blue and white country cloth, with pointed cotton caps on their heads. These garments are evidently from the north, and certainly they add considerable dignity to the appearance of these men. Mingling with the crowd are women wearing only a loin-cloth, and full-grown girls up to marriageable age, and youths, in a state of complete and apparently unconcerned nudity. These make up a scene as incongruous as could well be imagined.

A particularly shrewd and intelligent chief from a somewhat wild town in the Ibo country used to attend an important native court arrayed in a long cream-coloured gown, a scarlet fez on his head, with a wing of the black and white fish eagle mounted on each side of it, suggesting a viking helmet. His arms up to the elbows were covered with ivory bangles. Thrown over his shoulder was the long black tail of a horse mounted on a short handle, and he carried in one hand a brass-mounted iron spear or staff, the lower end sharpened, and the centre hammered out into a large oval of twisted iron. Round his ankles were rows of knotted red threads indicating his rank, and his feet were bare. The general effect, so far from being ludicrous, on the contrary was dignified and impressive. A fellow member of the same court frequently appeared in a French cavalry brass helmet with a white plume.

The foregoing descriptions were written in no spirit of ridicule or reproach, but because of the extraordinary incongruity of the scenes presented, and as affording illustrations of the process of the adjustment of primitive ideas concerning dress to the new conditions imposed by the opening up of a country which for untold generations had been sealed to the outside world.

It is not generally realized that in the past few years the Nigerian Eastern Railway, to mention only one example, has blazed a trail nearly 300 miles long from Port Harcourt near the sea-coast to the Benue in the north. It passes through country which was practically impenetrable because of swamps, rivers, hills, and a general absence of roads. Right in the midst of a cannibal and head-hunting people coal-mining was begun, and now electric light and power and all the latest mechanical devices of a Railway Engineering Establishment are in full swing. There is no doubt that such developments are too sudden from the point of view of the welfare of the primitive peoples affected, who have been left dazed and bewildered, and unable to adjust themselves to them.

In the matter of clothing, disease and death take a heavy toll by reason of the adoption of woollen and other garments intended for people of a temperate climate, who from early childhood have been taught the elementary laws of hygiene regarding the wearing of clothes. In primitive conditions, a man who gets wet soon dries in the sun or over the fire, but if he adopts, say, a cloth coat or other thick clothing. he is apt to keep on his wet things with disastrous results, such as pneumonia. He cannot be blamed for buying in the markets and stores unsuitable clothing, nor the " factories " for selling it, as they are out to sell what people will buy, and do not pretend to be philanthropic institutions. Unfortunately for the African who can read, well got up catalogues containing illustrated lists of clothing, hosiery, boots, scents, etc., are flooding the country, and it is scarcely to be wondered at if he succumbs to the solicitude of some enterprising Manchester or Liverpool firm who have done him the honour of addressing him by name through the post with the title of esquire, and asking for the favour of his esteemed orders. The word " catalogue " has already been incorporated into several West African languages.

Attempts have been made from time to time by members of various missions and others to dissociate the profession of Christianity from the adoption of European costume, as well as English names. In schools and colleges where uniform was provided, simple gowns of dark blue or white cotton cloth, worn with loin-cloths or knickers, proved most satisfactory. All such efforts in this direction have met with little success so far because of the suspicion of designs on the part of Europeans to keep Africans permanently in a position of inferiority. In matters affecting the standard of education, unless those of Europe are adopted, considerable opposition is aroused for the same reason.

The beginning of a national spirit is already discernible in certain directions in the Southern Provinces, and with it will come eventually a revolt against slavish imitation, and a determination to develop in matters of dress, education, and religion, on lines suitable to environment and to the peculiar genius of an African people surrounded by such wonderfully rich natural resources.

## II. Cloths.

From the days of Elizabeth there has been a considerable trade in cotton and cotton cloths from the Coast of Guinea. At the end of the sixteenth century a trading expedition from London reported an abundance of cotton and cloth at Benin. Benin appears to have been the great Guinea Coast emporium for the disposal of slaves, ivory, pepper, palm-oil, and other goods in exchange for manufactured goods of Europe, brought first of all by the enterprising Portuguese, and much later by our own countrymen. What the early explorers called Benin cloth most probably included that which was produced by Yorubas, Nupes, and Hausas, as well as that made nearer the coast in the Benin hinterland.

Before the suppression of the slave-trade in 1807, there appears to have been a very large trade in African cloths, which were sent to the Brazils and the West Indies, presumably for the use of the large African slave population of those lands. There was also a great demand for such cloths along the Coast to the south. They differed very little, if at all, from the two types which are still produced in the country.

There is first a kind of shawl or cover-cloth, plain white or with coloured stripes, made of two or three strips of cloth 15 to 20 inches broad and from 6 to 8 feet long, with a fringe 4 inches deep at each end. The cloth is worn by both men and women, who put it horizontally round the back, one end being brought from behind over the left shoulder, and the other under the right arm and carried over to the other end, also on the left shoulder. Should more freedom be desired, the cloth may be lowered to the waist, the top edge rolled over, and the end tucked in.

The second type of cloth is the loin-cloth. It is usually about 3 feet 6 inches long by 20 inches broad. The usual patterns are stripes of all widths, from a narrow line in dark or light indigo blue, or brown, to a 2- or 3-inch stripe, but a good deal is made without any colour at all.

During the Great War, when European cotton cloth was scarce and very dear, a great impetus was given to the native weaving industry, and both Africans and Europeans who used the country cloths testified to their excellence for strength and wear.

Some of the most valuable cloths, however, in the western district of the Lower Niger are not made of cotton, but of fibre made from a liana which grows freely in the clearings of the forests. The fibre is very much like flax, and when woven the cloth looks like very coarse butter muslin. When it is washed it becomes much closer in texture, and as soft and glossy as silk.

From very early days of contact with Europe, cloths of coloured silk and of other rich material were brought by the Portuguese to the Coast, where they were purchased in order to be unravelled and made up again to suit local African taste, according to designs which were remarkably striking and artistic.

In a district not fifty miles from Port Harcourt may be seen many vertical looms engaged entirely in making up, not the coloured cotton of unravelled cloth, but European cotton yarn of many colours, in wonderful designs. The cloth thus produced is called by the name of the people who weave it—viz., Akwete. The writer has seen vertical looms set up in verandahs of mud huts amid puncheons of palm-oil and all the greasy and smelly accompaniments of that industry, and wonderful original patterns in three or four colours being woven by women who seem to carry the designs in their heads, and the cloths kept perfectly clean.

The looms are large enough to make a cloth 3 feet 3 inches in breadth, which will fetch up to £1 when the pattern is well designed and executed in colours. No cotton of any sort appears to have been cultivated in this Lower Niger Delta area, and it is quite reasonable to suppose that in the early days slaves from the northern districts, where weaving was understood, were retained by their masters on the Coast to weave unravelled silk, woollen and cotton cloth to suit their fancy, until some enterprising trader imported the coloured cotton yarn which met all requirements.

## III. COTTON.

The people of the palm-oil region proper have never regarded the cultivation of cotton for export purposes as worth their while. The source of all their wealth is the oil-palm, which grows luxuriantly everywhere with practically no cultivation. The collection of palm-nuts, the preparation of the oil, the cracking of the kernels, and the transport by canoe or head porterage to the nearest market or "factory," involves nothing but congenial and leisurely labour, while the profit is comparatively large and certain.

In the case of cotton cultivation they recognize that to get anything like the returns they are now getting from palm-oil products, large areas, requiring much more labour than is at present available to keep fertile land free from weeds and bush, must be cultivated.

After the abolition of slavery, the minds of many good men in England were exercised as to the best way of fostering legitimate trade, not only as a sort of compensation for the loss of a most profitable trade, but in order to promote the stability and improvement of the African people, whose raw products were necessary to civilization.

One man devoted himself with great energy to this problem, and succeeded in interesting some leading Christian philanthropists. His name was the Rev. Henry Venn, the Honorary Secretary of the Church Missionary Society. His first efforts were directed towards finding out exactly what West Africa could produce, and he procured through missionaries specimens of raw products such as cotton, pepper, ginger, coffee, palm-oil, arrowroot, ivory, and ebony. These he submitted to experts, including the Director of Kew Gardens, who reported upon their quality and estimated their commercial value. In this way, through his personal efforts, arrowroot became an article of commerce.

To further his plans he formed a committee of philanthropists who were interested in the development of Africa; and through them arranged for some Africans to be brought to England for training in Kew Gardens, and for others to be educated for the medical profession. All this was done in such a way that the Church Missionary Society were not involved in commercial enterprises.

The attention of Venn and his committee was early directed towards the vast possibilities to the people of Africa, as well as to England, of the cultivation of cotton on a large scale. They recognized the fact that it was a matter which affected Manchester, and sought to secure the co-operation of those far-seeing, hard-headed business men. One of them, a cotton merchant, a Mr. Thomas Clegg, heard Mr. Venn preach in a Manchester church, and wrote that: "If Mr. Venn wants to promote Christian civilization in Africa, he had better teach the natives not to waste the products of their country." He afterwards, on his own account, did much to foster the cotton and general trade.

Venn succeeded in interesting the Baroness Burdett-Coutts and the Quaker Samuel Gurney, who helped to meet the cost of the very first cotton gins ever used in the Yoruba country. By 1859 there were between two and three hundred cotton gins at Abeokuta, and five or six presses, chiefly in the hands of natives. In 1858 the Manchester Cotton Supply Association sent out 2 tons of cotton-seed to Lagos for distribution, and in 1859 from Abeokuta, the centre of the cotton-growing area, were exported 644 bales of cotton.

In view of this encouragement so long ago of an important staple industry such as cotton, which Dr. Stock mentions in vol. ii. of his "History of the C.M.S.," it is interesting to note that the original impetus to cotton-growing in Uganda, which has attained huge proportions, came from a missionary of the same society.

### *Cotton Cultivation.*

Most of the cotton in the Lower Niger area is grown in the fertile forest region on the west bank of the Niger and above the Delta district. No special trouble is taken in its cultivation, and it has to take its chance with other farm crops, such as yams, maize, beans, and sugar-cane. The result is that the quality of purely native cotton is coarse, and the staple short in comparison with that which is grown from recently imported seed. There is nothing in this area to compare with the extensive cultivation of cotton in Kano and its surrounding country, which has grown cotton for untold generations. This is natural, because the Mohammedans of the north require much cotton for their voluminous garments, while in the south, on both banks of the Niger, are many tribes who wear little or no clothing.

### *Cotton-Spinning.*

A distaff is used, and it consists of a thin wooden rod of about a foot long. The spindle, some 8 inches long, is made of a thin, hard, but resilient piece of wood, carefully smoothed and fined down to a sharp point at each end. This is weighted by a spherical ball of white kaolin, about an inch in diameter and $\frac{3}{4}$ inch deep, through the centre of which the spindle goes and extends beyond it some $\frac{3}{8}$ inch. Both the ball and the stick are frequently decorated with black and red lines and colouring, and the construction is so good that with a slight twist they will spin like a top.

After the raw cotton has been picked by hand or rolled to separate the seeds, a handful of fluffed-up lint is put lightly on the top of the distaff, which for the purpose of spinning is held above the head with the left hand. Then to the upper point of the spindle is attached a wisp of the cotton-lint mass, which is carefully drawn out with the fingers of the right hand and regulated by passing the fingers up and down, aided by a sharp spin of the lower point of the suspended spindle, which twists the lint into thread. When a yard or two of thread has been spun, it is wound round the spindle until its weight is greater than the strength of the thread in the process of spinning.

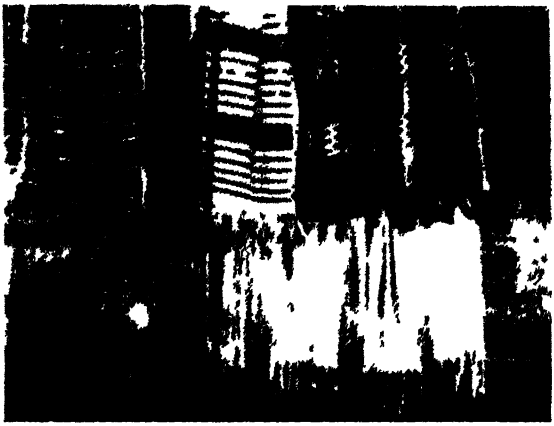
Spinning in the Western Ika-speaking area is always done by women and girls, and it is one of the most picturesque of their occupations. They sit down in the shade of a verandah or tree, or even walk about with their spindles and cotton lint, while conversation goes on uninterruptedly. So dexterously do they employ their hands that the motions seem to be almost mechanical, and the whiteness of the cotton shows up strikingly by contrast with the black skin of the operators.

### *Weaving.*

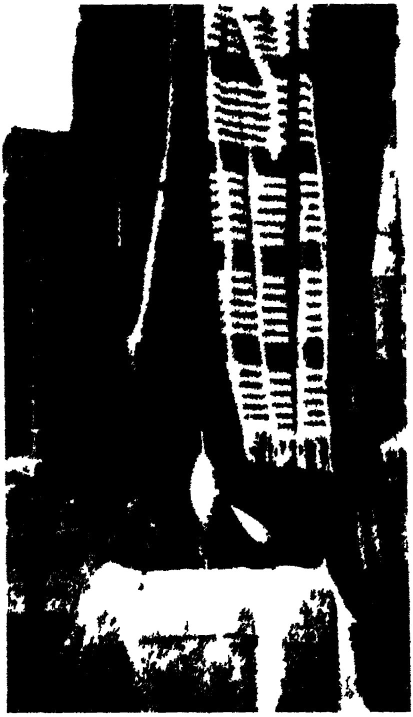
Both the Western Niger people and the Akwetes employ the simplest form of vertical loom. It is made of two stout upright posts, fixed usually in the verandah or the overhanging eaves of a mud house. Two smooth midribs of the raphia palm are attached horizontally—one at the top, the warp beam, and the other at the bottom, the breast beam, on to which the warp threads are hung and drawn taut. One rod forms a heddle and another a lease stick. The cotton wound on to a flat stick, notched at each end, forms the spool, which is shot through the shed from hand to hand, and the thread is beaten into position by a smooth wooden beater called a knife or sword. The weaving proceeds from the bottom upwards.

In conclusion the writer is of opinion that there is likely to be great agricultural development in the oil-palm belt of the Lower Niger, when the scientifically produced palm-oil from the Dutch East Indies becomes a serious competitor in a trade which has been practically a monopoly of West Africa for centuries. Attention will then be directed to the cultivation of the oil-palm as well as to the methods of extracting the oil, and probably there will be a general recognition of the value of raising crops such as cotton and ground nuts for export as supplementary sources of income. There will be a great demand for labour, and if tactful and sympathetic methods are adopted, there should be no great difficulty in attracting from the North Eastern part of the Ibo country all the labour required for the cultivation of such export crops in the fertile areas of the Niger valley.

The North Eastern area consists of long stretches of sandy soil covered with a coarse grass, scrub, and dotted about with clumps of trees—in the distance very much like English park land. This condition has been produced by the annual bush fires which have destroyed the forests and taken out the productive qualities of the soil.



SPECIMENS OF NIGERIAN CLOTHS.



ANOTHER VIEW. COTTON SPINDLES, BOTH WOUND AND UNWOUND, ARE SHOWN IN FOREGROUND

Woman Cotton Spinning.

An Ibo Chief.

The people are compelled to terrace their hillsides with earthen retaining walls, to get any crops at all. They manure their land in the vicinity of their houses with the daily sweepings from the compounds; dig in grass, and use up every hole made originally for puddling clay, as a bed for plantains, bananas and coco-yams; and raise mounds about three feet high in order to grow their yams. In spite of all these efforts, the period between the seasons is known as the time of famine, during which there is really a serious shortage of food, and young men often go out to find work to tide over this difficult period. This area is the most densely populated of the whole of the Southern Provinces, and in former days whole families were sold into slavery in order to raise money.

# COTTON AND GUNS

BY

R. R. ANSON.

On reaching Basra after having returned from three months' leave, John Coogan, Agricultural Officer, Baghdad, was met on the wharf by one of his colleagues, who handed him a telegram from Headquarters which read, "You are appointed Agricultural Officer Sulaimaniyeh. Necessary report least possible delay. Establish cotton experimental station, planting season commences April."

Next morning at 5.30 a.m. Coogan was at the station. The train was fairly well packed with a cosmopolitan collection of humanity, mostly Arabs, but with a sprinkling of Turks, Assyrians, Armenians, Kurds, Jews, and a few Russians. Everyone seemed in a frenzy of excitement, and all were chattering loudly in their respective languages. After having settled with his luggage, Coogan took a stroll along the platform, and on returning to his carriage found an Arab Gendarme waiting at the door. "Subâkum Allah bil Khăr Junarbik" (Good-morning, your honour), "and has your honour a servant with him for the journey?" "No." "My sahib has sailed by the big boat for England; I am free at present, and shall be pleased to attend to your honour's wants if you so desire." "How far are you going?" "To Baghdad, and thence to Sulaimaniyeh, where I have been given leave of absence for three weeks to enable me to see my people." "I shall be going to Sulaimaniyeh also. Will you be able to come with me?" "God be praised, I shall and willingly." "What is your name, and why are you serving with the Arab Gendarmes if your home is in Sulaimaniyeh? There are no Arabs there, are there?" "My name is Ahmed Beg. No, Sahib, there are no Arabs in Sulaimaniyeh. I am a Kurd by birth, and I joined the Arab Gendarmes in Mosul." Coogan's luck was in; here was a ready-made companion for the lonesome trek to Sulaimaniyeh, one who would prove very useful as a guide and interpreter, and, what was more, he had a rifle.

The train reached Baghdad at 8 a.m. on the following morning, and Coogan lost no time in reporting at the offices of the Agricultural Directorate. The Director had not yet arrived, so Coogan busied himself visiting old friends and acquaintances, and chatting about his various doings while on leave. Presently the Director came in. "Hello, Coogan, welcome back! Did you receive my telegram?" "Yes, sir. When am I to start?" "Just as soon as you possibly can. Only yesterday I received a wire from the Political Adviser in Sulaimaniyeh asking me to send you along with the least possible delay. You see, Coogan, the Kurds are anxious to find a substitute for tobacco, which was their main crop, but which they now find very difficult to dispose of, Bolshevism in Russia having affected Persia and unsettled its markets. I have suggested cotton as a substitute, and have put aside 300 lbs. of Triumph seed and about 60 lbs. of Webber 49 for you to take with you. You might give sugar beet and potatoes a trial also. The Political Adviser will lend you a Kurd who can speak a little English, whom he wishes you to train as an assistant. There is a train leaving for Kingerban on Thursday; do you think that you can manage to catch it? You will be able to take your car on as far as there by train, and then to drive to Kirkuk, a distance of about sixty miles, and the Magistrate there will then direct you. Keep your eyes open, and don't go unarmed; there have recently been quite a number of robberies and hold-ups along that road." "Right you are, sir! Shall I pick the seed up at the station?" "Yes. Good-bye, Coogan, and good luck."

The following Thursday morning saw Coogan and Ahmed safely installed on the train bound for Kingerban, plus a small Fiat car loaded at the back with cotton seed right up to the hood level. The same afternoon saw the little Fiat struggling along Kirkuk-wards, wildly protesting under its heavy load of cotton seed, and at each bump in the road the tyre studs made a rasping noise on its mudguards. At Kirkuk Coogan reported to the Magistrate, who told him that he would be unable to take his car beyond Chemchemal, a place situated about thirty miles north of Kirkuk, owing to a bridge having been washed away. Coogan and Ahmed reached Chemchemal without further mishap at noon on the following day. The district Political Officer was out on tour; Coogan therefore left a note behind asking him to take care of the car, and, making arrangements with one of the neighbouring Kurdish chiefs, managed to secure a horse and an escort.

On the second day they reached the summit of a range of high hills, whence they could obtain an excellent view of the country for miles around. "Yonder is Sulaimaniyeh," said Ahmed, pointing to what appeared to be a picturesque little village nestling under a high range of hills, behind which could be seen the snow-capped mountains of Persia. It all looked very peaceful and inviting.

Coogan reported on arrival to the Political Adviser, and started on his somewhat multifarious duties. Such matters as settling on the site for the experiment station took some time, and it was three weeks later before he was able to return to Chemchemal to collect his car and luggage, a temporary crossing having by that time been made beside the broken bridge. On arrival, he found the District Officer in his house. "Hello, Coogan!" said he, "come in. I heard that you had come to the district." "How are you, Bungo? You are looking thinner." "Yes, I think that I am thinner, although I have only been back from Blighty for three weeks. I have been working like the deuce since my return. I am afraid that hell is going to be let loose here soon, Coogan. I'm jolly pleased to see you; it's a pleasure to see a white man once in a while. I see so very few here, and the place has been getting on my nerves lately. You will no doubt remember my having told you, when I spent the day with you at Rustam, how after three years of hard scheming I had eventually succeeded in splitting up the Hamawan tribe into four groups, and in the event of any of them giving trouble I was able to quiet it in no time by setting the others against it?" "I remember; that was the tribe under Karim Fattah Beg, of 1,000 rifles strong, wasn't it?" "Yes; well, that work has been undone during my absence. You remember that I turned Karim and his cut-throats out of his village, and gave it to a more friendly fellow, who caused little trouble?" "Yes." "Well, Karim has been given the village back again, and he is becoming stronger and stronger each day. The groups which, after so much trouble, I managed to persuade to leave his camp, are rapidly going back under his wing again, and within a month he will be stronger than ever he was, and I tell you, Coogan, if this is allowed to continue, the whole place will be seething with revolt; even now it is none too safe for a Britisher to wander about in the Rania district. The Turks were unable to keep the Hamawan in control during the time that they had the governing of this place, and they had a whole division of troops stationed at Sulaimaniyeh. I am going up to Sulaimaniyeh next month to throw my hand in. I like the place, and I get along quite well with most of the Kurds, but I hate the thought of having Karim Fattah Beg in power again; the place is not large enough for both of us—either he has to go or else I do."

Coogan had a head full of very mixed thoughts when he left Chemchemal on the following day; he was fond of Bungo, and knew him to be sound, and the very last person to dub as a scaremonger.

Most of the next month was spent in planting up the experiment station with the cotton, sugar beet, and potatoes. A certain amount of cotton seed was distributed to some of the more intelligent Kurdish fellahin, but they are difficult and obstinate people to deal with, and in spite of his detailed instructions as to the best methods of planting, they insisted upon mixing the seed which he had given them with some of their own, and sowing the lot broadcast. This local variety most probably found its way into Kurdistan from Persia, and is an inferior variety which grows twelve inches in height, and produces bolls about the size of a large grape. Their custom in the past had been to pick the whole boll and then to extract the seed cotton from the burr in their houses, after which the hand-ginned lint was used for the padding of clothes and quilts.

The place seemed so peaceful that Coogan began to think that Bungo had been mistaken. The latter duly arrived in Sulaimaniyeh and tendered his resignation to the Political Adviser, who, realizing that he had in Bungo an extremely efficient and capable man, tried to persuade him to remain in the Service, and thinking that the continual isolation had been preying upon his nerves, offered him a post as Police Officer in Sulaimaniyeh, but Bungo would not accept it. He seemed excited and agitated, anything but his usual self. His resignation having been at length accepted, it was arranged that Makett, who had been an officer of the Kurdish Levies, should take his place, and together they returned to Chemchemal. They had been there a few days when Bungo received a note from Karim Fattah Beg, in which he stated that he had heard that Bungo was about to leave; in the past they had been enemies, but he hoped that Bungo would allow bygones to be bygones, and that he and the new Hakim would lunch at his village, and that Bungo and he would part friends. Karim had sent a similar note to the Political Adviser in Sulaimaniyeh, and he, thinking that it would be a good opportunity for Makett to meet Karim Fattah Beg, advised Bungo to accept the invitation. Colonel Maya, O.C. Kurdish Levies, getting to hear of this, said that on no account would he allow either of them to go unless they took with them a strong escort. "But he will not meet us if our escort outnumbers his, sir," said Bungo. "How would it be for you to bring your regiment to within a mile or so of his village; Makett and I could then ride on into the village with our servants, and if we are away for more than two or three hours you could send a search party?" "That would be a fairly sound arrangement," said Colonel Maya, and it was thus arranged.

Bungo and Makett set off together, and with them went four

Kurdish Levies and their own personal servants. Karim, with a following of forty-five, rode out to meet them. He was a small man, and, for a Kurd, possessed quite a fair complexion, being of mixed descent. His face resembled a slice of cheese, and his little beady green eyes, set closely together, had in them an evil cunning. He greeted them in the orthodox fashion of the Kurd, first touching his forehead and then his chest with the tips of his fingers, and they then moved towards the village, Makett and Bungo riding on either side of Karim Fattah Beg, while behind them rode their six followers, while Karim's forty-five riflemen brought up the rear. At a given signal, Karim's men raised their rifles and shot Bungo, Makett, and the six followers in the back, killing Bungo, Makett, and four of the followers outright, and seriously wounding the other two.

Colonel Maya, finding that Bungo and Makett did not return at the appointed time, took his regiment into the village, which he found to be completely deserted. He sent out search parties through the whole countryside, and it was not until nearly midnight that one of the patrols stumbled across first the dead bodies of the unfortunate Bungo and Makett, where they had been thrown down by the roadside, and then the two wounded men, who were brought into Sulaimaniyeh, where they were put into hospital. One, who had been shot through the stomach, never regained consciousness; the other recovered, and was able to explain exactly what had occurred.

Colonel Maya at once set out after Karim and his band of murderers, but Karim, having had everything in readiness for flight, had a good start. Maya, after a fruitless chase which lasted some days, was compelled to return to Sulaimanyeh to refit, as a great number of his men had gone down with malaria.

About this time news was received from Rania (a district situated about sixty miles north of Sulaimaniyeh) to the effect that 400 of Mustapha Kemal's troops had concentrated at Rawandiz, and that seventy-five Turkish officers were recruiting neighbouring Kurds and mobilizing there also, their objective being to capture Rania and ultimately march on to Sulaimaniyeh. Coming on top of recent events, this news was most disquieting. Colonel Maya at once wirelessed to Baghdad for reinforcements, and in consequence an Arab regiment of Gendarmes received orders to proceed from Kirkuk to Sulaimaniyeh. Prior to all these disturbances, all temporary officers had been demobilized and replaced by regulars from England —who inevitably had no knowledge of Arabic. Coogan, who had had some previous cavalry training, and possessed a fair knowledge of Arabic, was asked if he was willing to be attached to the regiment as interpreter, and gladly accepted, as he was anxious to help in avenging the murder of his friend Bungo.

Three days afterwards he donned his old cavalry uniform and set out with the small expedition under the command of Colonel Maya. They took with them two men from the Hamawan tribe as guides, and pushing on, they made forced marches of fifty and sixty miles per day. The further they went the more barren and desolate became the country, and the more fatigued their horses, while many of the men contracted malaria; things reaching such a bad state that the expedition was compelled to return to Chemchemal. Here word was received that Karim and his rabble had reached Rawandiz, and had joined up with the Turkish troops. Rania was being threatened, and had only one platoon to guard it. Coogan, together with twenty-six dismounted men, was despatched to hold the Bazzian Pass until a relieving officer could be sent from Baghdad to take over, while Colonel Maya pushed on to Rania with all the remaining comparatively fit men available. Six days passed without anything exciting happening; the relieving officer then arrived in a Ford vanette, and Coogan returned to Sulaimaniyeh. Here he found that his assistant had looked after the farm very satisfactorily during his absence; the cotton was squaring well, the potatoes looked healthy, but the sugar beet had only germinated at irregular intervals.

Colonel Maya returned a few days afterwards, looking haggard and a mere shadow of his former self, having contracted malaria very badly. Further disquieting news had come in; the Turks were advancing on Rania, reinforcements had been wired for, and a Sikh regiment was on its way to Rania from Baiji, a distance of roughly 120 miles, the Commanding Officer having been brought up by aeroplane.

Some three weeks afterwards, a message was received by wireless to the effect that the Sikhs had been completely overwhelmed, and had been forced to retire on Koi Sinjak, the enemy being estimated at 3,000 strong. This meant that Sulaimaniyeh, with its force of Kurdish recruits numbering about ninety, a section of twelve Assyrian machine gunners, and about sixty Britishers, was completely cut off from all communication with Kirkuk. Colonel Maya sent a message through to Baghdad by wireless explaining the position, and asking for a sufficient number of aeroplanes to enable him to evacuate all the Britishers, together with the Christian and Indian personnel. A reply came back from General Headquarters instructing him to hold Sulaimaniyeh for as long as he was able, and informing him that there were only two aeroplanes available, the remainder being engaged upon punitive operations somewhere on the Euphrates. On receipt of this, Colonel Maya summoned all the Britishers to the barracks, and outlined the situation. "We are in rather a hole," he said; "the Sikh regiment has been completely routed, and forced to retire on Koi Sinjak. This means that we are cut off from our only practicable line of retreat by a mixed force of Turks and Kurdish rebels, numbering about 3,000, with four field guns, and at least six or seven machine guns. I have wirelessed Baghdad for assistance, but, beyond providing us with two bombing planes, they are apparently unable to give us much help, as their reserves have been sent to quell a rising which has broken out somewhere on the Euphrates. Within three days, or less if they make a forced march of it, the enemy forces will have completely surrounded us, and it will be hopeless for us to try to escape. I have fortified these barracks as well as I can, and we have sufficient food supplies to last us for two weeks. Our forces consist of ourselves, twelve Assyrian machine gunners, and the Indian followers. As we cannot put any confidence in the Kurdish recruits, I propose to take their rifles from them and then to dismiss them all to their villages. In this way they can quietly disperse, and will not be known to the Turks as having served under us. We will then hold the place for as long as we can. Has anyone a suggestion to make?"

The little group looked at each other by no means happily, and a short conference followed. Then one voiced the general opinion: "We all agree, sir, that it would be better to our tastes if we were to make a dash for Kirkuk and attempt to escape that way; some of us might get through, and at any rate we would prefer to die fighting in the open rather than be caught like rats in a trap." "My good men," said the Colonel, "the moment that we attempt to move out of this town the people will become suspicious, and we should not get far; as it is, I am taking a risk of arousing suspicion by disbanding the recruits, but this is a risk we must take in fairness to them. At present the townspeople are just watching to see which way the wind blows; they do not yet know the Rania affair, but it won't take long for the news to reach here, and the moment that it does, they will round upon us [illegible] hungry pack of jackals."

There was silence for a moment, then Coogan had a brainwave. "How would it be, sir, if I were to leave here in civilian clothes, as I have been in the habit of doing, and make for Midan, where I believe there is a squadron of Arab Gendarmes stationed. By making a forced march, I could reach there in a day and a half, and if I came back with them towards Sulaimaniyeh, you could leave here in two nights' time with the Political Officer's car and the Ford vans, and drive towards Halebja, as the road is passable for twenty miles or so, I believe. I would then meet you with the squadron at Aradikan, and we could make our way through Persia back to Iraq."

The Colonel thought for a moment. "Yes, Coogan, you can try that if you like," he said. "I would like to take a guide who can be depended upon, and preferably one who can speak Arabic, as I know very little Kurdish," said Coogan. "I don't think there will be any difficulty in finding a man who can speak Arabic, Coogan, but there are few that can be depended upon; anyhow, I will ask McDowell to send two of his best men around to you early tomorrow morning." "Thank you, sir."

After this, the little gathering broke up, and Coogan returned to his quarters to instruct his servant to pack his belongings in readiness for an early departure next day, and to make sure that none of his treasures were left behind, as he did not expect to return to Sulaimaniyeh again. He was called at sunrise, and, after a hasty breakfast, he set out for Midan, accompanied by his servant, who perched himself upon the pack horse amongst his master's kit, and two Kurdish guides, one tall and dark, with heavy features and a pock-marked, evil-looking face, the other a short, thick-set man of middle age. Coogan, to his annoyance, recognized the former as a would-be cotton grower with whom he had had a considerable difference of opinion. He had explained to him, as he seemed more intelligent than most of those who came for seed, the necessity for keeping the new variety separate from the local seed. He had gone into the question by planting properly and spacing out the seed instead of sowing it broadcast, only to find his advice entirely disregarded. Further still, this man, he felt quite sure, had prevailed on others who might have acted on his instructions to pay no heed at all to his patient explanations. Still, there was no time to be lost, so Coogan accepted his guides and started on his journey.

They rode quietly out of the town unmolested, and as they left it behind, Coogan breathed more freely, as he half expected to have been prevented from leaving it. When they had travelled for about six miles, they came to a branch track, which led to Shahbushair, and the guides, who had been riding ahead, proceeded up this track, Coogan keeping to the main track which led to Halebja, and which he knew to be the right direction. Seeing that he had not followed them, the guides came galloping back. "Where is the Sahib going ?" said the tall one. "I am going to Halebja," said Coogan. "But the Sahib in Sulaimaniyeh said that you were going to Sharbushair."

"I don't care what the Sahib said; I am going to Halebja." "Why are you going to Halebja?" said the guide, who had become suspicious. "The people of Halebja have reported a disease in their rice crops, known as sharrah, and I am going to see if it can be remedied," said Coogan. This seemed to satisfy the guide, and he and his companion rode on without making further comment.

In Kurdistan, stationed along the main routes at intervals of nine miles or so, are small coffee houses, and it is customary for all who travel along the road to call in for a cup of coffee, which costs but a few annas, and to water and feed their horses before continuing their journey. Coogan, wishing to lose as little time as possible, passed the first one, but, noticing that the guides were eyeing him in a curious way, and not wishing to make them suspicious, called in at the next; but instead of spending the usual time, which is about twenty minutes, he stayed about ten. This was looked upon with disfavour by the guides, who became sullen and surly. At 4 o'clock they reached a village about forty miles out of Sulaimaniyeh, which is looked upon as the half-way camping place between Sulaimaniyeh and Halebja. Here the guides dismounted and commenced unpacking their saddles. "What are you doing?" said Coogan. "We are staying here for the night," said the taller one, who usually acted as spokesman, and whom Coogan by now disliked even more than he had at the close of the cotton-planting contest. "We are doing nothing of the sort," said Coogan. "Then where do you want to go?" said the guide. "I am going as far as Arabikan tonight." "Are you mad? Arabikan is a four-hour ride from here, and it is now past 4 o'clock." "I know the distance, thank you," said Coogan, "and I intend to reach there tonight." "Then you go by yourself, for we are tired, and require food." "What!" said Coogan, "are you like women, and too weak to ride the distance? I thought that the Kurds prided themselves upon their strength and good horsemanship. I am going to Arabikan; I am not tired." "Then if you can ride the distance, we can also," said the guide, somewhat ruffled, and on they went, reaching Arabikan at 8 o'clock. Coogan had been intent on doing so because Arabikan he knew to be populated by a tribe of Arabs who had settled there some sixty years previously, and he felt that he would be more secure there, it being customary with the Arabs to protect a traveller, no matter what his nationality or religion, provided that he has broken bread with them in their camp.

The headman, or sheik, a hospitable old man with sharp features, keen black eyes, and a long flowing beard, came out of his goats' hair tent to greet them. "Salaam alleckum sardeeki, tafuldil estariah, shallun was ahallun" (The peace of Allah, my friends. Enter, sit you down, and welcome).

Coogan's servant took his horse, a beautiful little Arab thoroughbred, pegged it out, and gave it some tibbin, and then commenced to unload the pack horse. Thinking that he would never return to Sulaimaniyeh, Coogan had taken one or two extra suits of clothes, and three or four pairs of boots, together with a few other things that he did not want to lose. The tall pock-faced guide seemed very interested in the unpacking operation, and seeing several pairs of boots and two suits of clothes roll out of the valise, he said, "Does the Sahib take as much kit as this when he goes on tour?" "No," said the boy, a local but intelligent Kurd. "Then why is he taking so much now?" queried the curious one. "I don't know," said the boy. "I do," said the guide, "I heard him asking the sheik the way to Midan. He said that he was going to Halebja; why does he ask the way to Midan? I'll tell you. The English are clearing out, they are afraid of Mustapha Kemal's troops; but your Sahib shall not go, we shall take him and you to Karim Fattah Beg."

Coogan, who was sitting on the grass nearby. overheard this conversation; the guide, thinking him unable to speak a word of Kurdish, had not troubled to lower his voice. Coogan's feelings would be difficult to describe. They were a mixture of fear and rage. He certainly did not like the way that things were going, and was quite relieved when an old woman appeared, carrying a copper tray laden with eggs, dates, and khabaz—a local bread. This was a sign that the Arabs were not hostile, and that while he remained with them he would probably be fairly safe, but even so he did not like the way in which the pock-faced guide was looking at him, and he had determined at the least sign of rebellion to shoot that gentleman, no matter what might happen afterwards. The meal finished, the two guides walked down the bank of a creek on which the village was situated, and commenced to talk in undertones. Presently they began to argue, and so worked up did they become that they raised their voices, and Coogan could hear every word that was being said. "I shall take his horse and you may have the pack horse; the kit we shall divide," pock-face was saying. "No," replied the stumpy one, "I shall have his horse."

Something had to be done. Coogan sat on his valise and watched, and as soon as the guide's back was turned, he quietly slipped a clip of cartridges in his rifle, cocked it, and put it beside him in readiness for use at a moment's notice. Presently the old Arab woman who had brought out the tray of food came to collect it. She had in her hand some cigarettes, and came over to Coogan and offered him one, and while he was lighting it, said, "Sahib, your guides are very bad men; you do not know what they are saying. You should never have men for guides unless you are able to speak their language. Take my advice and watch your guides, Sahib; they are not to be trusted." Coogan thanked her, then, placing his rifle by his hand, crawled into his flea bag, feeling fearfully tired; the smaller of the guides had already gone to bed, and lay parallel to Coogan but a few yards away, and was fast asleep. The tall one, seeing that Coogan had turned in, came and placed his blankets just behind Coogan's head. For once in his life Coogan was thankful that the mosquitoes were bad, as without them he must certainly have fallen asleep, and he thought that to sleep would be fatal. He got up and went over to his horse, gave it some more tibbin, and then, returning to his valise, pulled it round so that he was able to watch pock-face; then, pulling off his jack boots, he again got into his flea bag. "The Sahib is unable to sleep tonight," said pock-face in Arabic. "No," he replied, "the mosquitoes are very bad."

For fully half an hour Coogan lay thus, with his finger on the trigger, his eyes half closed, but keeping a keen watch on the Kurd. At last the latter, unable to bear the vicious attacks of the mosquitoes, pulled his long flowing sleeve over his face and fell asleep. After waiting for a quarter of an hour so as to make sure that the Kurd slept soundly, Coogan got up and bent quietly over him, took his rifle, withdrew the bolt, and threw it into the creek. Replacing the rifle, he pulled on his boots again, and taking up his own rifle, crept over to the small stumpy guide, and pointing the rifle in his face, gave him a kick in the ribs. The Kurd sat up in a startled fashion, a look of amazement on his face. "Get up," said Coogan quietly. "Saddle the horses! If you make any noise I'll shoot you dead, you dog." The Kurd obeyed; he was still half stupid from slumber. "Now," said Coogan, "ride for Halebja as hard as you can; if you slacken your pace at all, or turn your head around, I'll blow your brains out." Just as they were level with pock-face's bed, he was wakened and jumped up. Picking up his mauser, he saw that the bolt was missing, and when he raised his eyes again they looked straight down the barrel of Coogan's rifle. "If you make any sound," said Coogan, "I'll kill you," and digging his spurs into his little Arab steed, Coogan dashed off behind the stumpy guide, who went for dear life, and hardly slackened pace until Halebja was in sight. There was a faint glow in the sky, and dawn was about to break. " We shall not be able to go into Halebja, Sahib ; they will shoot us if we go in by night. It would be better if we made for a Kurdish village nearby, and went into Halebja by daylight." " Then take your choice," said Coogan, " for I shall shoot you if you do not go in." And murder was then closer in Coogan's mind than it had ever been. The guide, looking round, gathered that he was determined, and rode on without another word.

Nobody challenged them as they entered Halebja, for there was not a soul about. They made straight for the Magistrate's house, and on reaching it were informed that he had gone on tour, and would not return for two or three weeks. " Is the Police Officer here ?" asked Coogan. " No," said the farrash who had answered the door, " he left here three weeks ago for Baghdad." " Take me to the police barracks," said Coogan, turning to the guide. When they reached the barracks it was bright daylight. Halebja had evidently had no news of the recent events. The police sergeant who met them was most respectful to Coogan, and asked if he required any breakfast. " No, thank you," replied Coogan, " but I should like some sleep; I am tired, I have ridden a long way." The sergeant disappeared into one of the rooms nearby, returning again laden with a pillow and blankets, which he placed in the shade; then taking Coogan's rifle he made off again. " Where are you going with that," asked Coogan. " I am going to put it in the armoury, Sahib; it will be safer there." Coogan, not wishing to arouse suspicion, thought that it would be best to let it go—anyhow, he still had his revolver.

No sooner had his head touched the pillow than he was fast asleep, awaking about an hour afterwards with the hot sun streaming on his face. He sat up and stretched himself. In the far corner of the barracks he saw the guide with a group of police all squatting around him; he was evidently telling them of what had taken place during the former twenty-four hours, and getting an excellent hearing. Coogan got up and walked over towards the group, intending at all costs to break up the meeting before the guide had told them too much. The sergeant was saying, " Well, we shall have to detain him," when an Arab farrash from the telegraph office came in the gate. " Inter el Hakim Zerrah ?" (Are you the Agricultural Officer ?) he asked. " Yes," said Coogan. The Arab then handed him an express telegram. Coogan tore it open and read, "Hit the floor right smart when you spot a bus, and show yourself plainly on ground aaa If you don't get this by 4.30 tomorrow beat it at once as per former arrangement aaa Get some armed blokes from the queen's son for company aaa Shop closed aaa Bus will arrive four. Dunn for Pol. Sul."

At first he could make neither head nor tail of it. What *did* Dunn mean by a bus? "Get some armed blokes from the queen's son," he understood that easily enough—the queen was the head woman of the Jaff tribe, who was domiciled in Halebja; he would make for her house at once. Turning to the messenger, he said in the vernacular, "Do you know where the Khanima lives?" for that is how she was known to the Kurds. "Yes," replied the Arab. "Take me to her house as quickly as you can," and out they went together. The police were much too interested in what Coogan's guide had to say to notice them. On reaching the Khanima's house, which was a very large one of Persian architecture, Coogan, leading the way, stumbled into what appeared to be the women's quarters. He was met by a servant who conducted him out on to a balcony arrangement on the second floor, telling him to wait while he went to fetch the Khanima. "You had better remain with me to act as interpreter, as I cannot speak much Kurdish," said Coogan, turning to the Arab.

Presently, out came out a weird-looking creature, dressed in a long robe, with a cummerbund of brightly coloured silk interlaced many times around her waist; her head was swathed in a huge turban of purple and green, and a few black curls, obviously dyed, protruded from beneath. Her face was brightly coloured with pomegranate skin, and her eyebrows were blackened. Coogan made himself known, as this could be none other than the wonderful Khanima of whom he had heard so much. "The Political Officer from Sulaimaniyeh advised me to come to you. You see, I require a guard of about twenty men to see me safely to Midan, and he suggested that you might be able to oblige me." "Certainly, but why do you want so many?" said she. "It has been reported that the hills between here and Midan are full of thieves and robbers." "Very well," said the old woman, "when do you want them?" Coogan did not have time to reply, his ears having detected the sound of an aeroplane. Dunn must have meant an aeroplane—the bus was an aeroplane. Leaning out of the balcony, Coogan could see a "Bristol Fighter" making straight for Halebja, but Dunn had said that it was coming at four, and it was not yet eight o'clock in the morning; however, that did not matter, it was an aeroplane. Turning to the Arab, Coogan said: "Tell her that I must make a smoke signal to this 'plane. It evidently wishes to land, and there is no one to show it the landing place."

He did not wait for any more, but bounded down the stairs, taking them two at a time, and rushed to the bazaar. A glance behind showed him that the Arab was running after him, and many of the Kurds in the bazaar, anxious to see what all the fuss was about, joined in the chase. Out into the open went Coogan, running as he had never run before, and yards ahead of the others, who seemed to multiply rapidly. The 'plane by this time had come down quite low; Coogan could see the pilot waving his hand. He stopped and waved; the 'plane almost landed, then went up again. made another circle, and finally landed and taxied over to where Coogan stood. It stopped, but the pilot did not shut off the engine, and the propeller was still buzzing around. "Are you the Political Officer here?" shouted the pilot. "No," Coogan shouted back. "Where is he?" "He has left here." "Never mind; get up behind as quickly as you can," said the pilot. Coogan scrambled up. There was a bag of earth in the rear seat evidently put there for ballast. Coogan had no sooner straddled it than the pilot opened up his engine and took off again, not even giving Coogan time to fasten the belt around him. On looking down, he saw a group of Kurds looking on in stark amazement. When they were well in the air, the pilot turned his head back. "Who are you?" he shouted. "Coogan is my name, and I am Agricultural Officer. Sulaimaniyeh," Coogan replied. "Have you got any paper?" yelled the pilot. "No; only a ten rupee note." "That will do, and give me one of your cartridge clips." Coogan handed both over. Presently they were flying over Sulaimaniyeh, and Coogan, on leaning over, saw a sight which thrilled him to the core. At each corner of the aerodrome was stationed a machine gun, aeroplanes seemed to be everywhere; there were twenty-nine in all, "Bristol Fighters," two huge "Vickers Vimys" A. 9's, and small scouts. The air was vibrating with the continued purr of their engines. One after the other they were landing, taking in passengers and taking off again, three or four being on the aerodrome at the same time. In a far corner was a huge blaze, caused by the Government cars over which petrol had been poured and then set ablaze. Around the aerodrome squatted hundreds of Kurds, interestedly watching the proceedings, but not daring to prevent or hinder them in any way, evidently appalled by the spectacle, as would be many nationalities more civilized than they. The pilot circled round once, then writing "I have rescued Coogan" on the back of the ten rupee note, he put it into a handkerchief together with the clip of cartridges, which he used as a weight. He threw it over, landing it near Colonel Maya's feet, who was standing beside the Political Adviser and directing operations. The pilot then gained height and flew off in the direction of Kirkuk. Coogan could see what appeared to be a lot of ants moving about fathoms below; the pilot pulled a lever, the 'plane dived its nose down suddenly, lurched, and then righted itself. There was an explosion somewhere down among the ants. "That's one for them to go on with," shouted he, "I wish that I had some more for them." It was not until then that Coogan realized that he had released a bomb. Kirkuk came into sight. The dust was fearful; 'planes seemed to be everywhere. The pilot put her head down, as it was difficult to see anything for the dust; the wheels touched, bounced, then stopped. The pilot undid his belt, took off his goggles. "Thank God for that, I thought that we might run out of petrol any moment; I didn't have any too much. I think that I have bust my undercarriage, but that is a detail—lucky to get down at all. I couldn't see what I was doing."

Together they scrambled to the ground. Coogan thanked the pilot, and then stood watching the incoming 'planes land and discharge their human cargo. He was awakened from his reverie by a smart slap on the back, and on turning round saw the smiling face of Dunn. "Where did you spring from?" said that worthy. "From Halebja; many thanks for the wire." "By Jove, Coogan, I am pleased to see you; we thought that you were a goner for certain. Just after you left, the Colonel got a wire from Baghdad saying that they were sending out 'planes to rescue the mob. We sent three cars out to try and pick you up. I don't know how far they went, but they missed you." "Yes," said Coogan, "I took the short cut." "Oh! is that how it was? Well, as a last hope I thought of sending a wire to Halebja just on the off-chance of you calling in there. I put it in American slang so that the operator would not understand it." "Well, I must say I am very grateful to you; but for that wire I don't know what would have happened to me," replied Coogan.

Coogan and his fellow refugees were forced to remain for a week in Kirkuk, the Air Force having run completely out of petrol, and a fresh supply had to be brought up from Baghdad in a "Vickers Vimy." The Air Force did wonderful work, and lost only one 'plane, which crashed whilst attempting to land at Sulaimaniyeh. Fortunately, its pilot escaped uninjured, and the whole of the garrison at Sulaimaniyeh were rescued safely.

This was the first, and will probably be the last, attempt that will be made for some little time to come to improve the cotton grown in Kurdistan.

# THE IMPERIAL AGRICULTURAL RESEARCH CONFERENCE

THE first of these conferences has lately been held, and attended by a very representative body of men engaged in, or directing those engaged in, research in the various countries of the Empire. A number of important conclusions were arrived at, which may have a far-reaching effect upon future progress, and it will repay us to give these some consideration.

The subject of the recruitment and training of agricultural officers for overseas was thrashed out, and certain slight modifications in the plan now followed by the Colonial Office—devised upon the lines of that pursued by the Corporation—were suggested, based upon actual experience, such for example as that the work done by a student in his first year in England should be more carefully co-ordinated with that done in Trinidad in the second. To do this effectively will of course require some kind of conference between the officers engaged in the first and the second year of training. But it is clear that matters should not be left in such a state that it is possible that a young man under training may receive that training in two portions that are not intimately connected the one with the other.

The position of scientific officers in agricultural departments, and their relation to the administrative staff, was also discussed, and it was proposed to distinguish a class of "specialist" officers from a class of "agricultural." Both, however, are equally concerned in agriculture, and it would seem desirable to draw some happier distinction between the two. A sharply marked distinction like this will tend to prevent any crossing of the line, though this may often be desirable, and many excellent administrative officers have at various times been drawn from the specialist class.

It was also pointed out that the primary work of the latter officers was observation and investigation, and it was urged that they should be given greater facilities for travelling, to acquaint themselves better with local conditions, and to study at first hand the work of the agricultural officers. The weak point in the equipment of this class at present is the tendency for it to be too much of the laboratory type and too little of the field. It was recommended that a primary requirement in their equipment should be a good knowledge of general agriculture. Such a knowledge is a great aid to the specialist in his own work, and tends to keep him from making too wide excursions along side lines, or giving unpractical recommendations to the ordinary practical agriculturist. The first specialist officers employed in the tropics—notably Mr. Green, the entomologist—owed much of their success (to which is due the great extension of specialist work in recent times) to the fact that they had a good knowledge of general agriculture, with its possibilities or impossibilities in relation to the special work which they were carrying out.

Another item which was considered was the formation of bureaux, like the existing Bureaux of Mycology and Entomology, for the proper collection and dissemination of information. The great lack that one finds, when working in the tropics at some problem that turns up, is that of much of the necessary literature in which to trace what has already been done towards the elucidation of that problem. So enormous has the bulk of scientific literature become, especially of recent years, that this problem is one to which it is difficult to find a practical and economical solution, though a central lending library is a conceivable proposition. But there is one way in which a great deal of assistance may be rendered to the more or less solitary workers in the tropics, and one which will become of greater value and importance the longer that it is pursued, inasmuch as the older literature will become obsolete. That way is the provision by central bodies, who have command of all the periodical and other literature, of abstracts giving the gist of all the very numerous articles that are published, containing information of greater or less value to those who are working at any given subject. Without such information there must be a terrible waste of work, in that the same ground will so often be gone over again and again—and usually unnecessarily. A good abstract will at least tell the worker the main points of what is contained in the original paper, so that he will know whether he must, or need not, obtain possession of that article, for a time at any rate. Such abstracts we have endeavoured to supply, for the extensive literature upon cotton, in the pages of this Review, and such abstracts are supplied with great success by the Bureaux of Mycology and Entomology.

This subject was considered at the Conference, and while it was thought that in many branches of work the time had hardly arrived for the formation of central bureaux of this kind, their establishment was recommended in connection with Soil Science (bureau at Rothamsted) and Animal Nutrition (at the Rowett Institute at Aberdeen), while smaller ones were also suggested for Animal and Plant Genetics, Agricultural Parasitology, and Fruit Production.

Another matter of great importance that came up for consideration—one to which that last dealt with is but a preliminary—was the question of agricultural research itself. Abandoning the idea that research stations should be chosen for geographical or political considerations, it was considered that they should be selected in reference to the actual agricultural needs of the Empire, and that their work must not be considered as in any way a substitute for the work of the local agricultural departments. It should be work of wider and longer range, upon the results of which the local agricultural departments, and others interested, may draw in carrying on their own work with its special application to the needs of local agriculture and industry. This pronouncement should be a useful warning, for there has been a distinct tendency to a move in the other direction.

In this connection, attention should be drawn to a useful and timely paper upon "Tropical Agricultural Research in the Empire, with Special Reference to Cacao, Sugar Cane, Cotton, and Palms," by Dr. C. A. Barber, C.I.E., the teacher of tropical agriculture at Cambridge, formerly of Madras, which has just been published by the Empire Marketing Board through the Stationery Office (price 1s. 6d.). He points out the increasing tendency for tropical departments to work for the benefit of the native agriculture of the country in which they are, work for the agriculture of the European settlers gradually tending to fall into the hands of special institutes, like the Tea Research Institute recently established in Ceylon, and like those which function on the large scale in Java for sugar, etc. He points out the extraordinary extension of scientific research work in tropical agri culture that has taken place in the last thirty years, and the danger that arises from too great specialization with too little knowledge of general field agriculture—this tendency may, however, correct itself, provided that the special officers dealing with one crop only, who are now being appointed, are required to study that crop in all its aspects and its relationship to the general agriculture of the country.

While at one time the idea prevailed that diseases, for example, might be studied as if they were a watertight compartment in the agriculture of the crop concerned, this is now tending to change in favour of the growing appreciation of the fact that they form part of the general agriculture, and may often be better dealt with by improvements in methods that seem at first sight as if they had nothing whatever to do with the diseases.

The proportionately increased demand for tropical products, predicted twenty years ago, is now becoming very marked, and in order to meet it a more rapid increase in crop production than in population is required. This, however, is more easily said than done, especially in view of the fact that a large part of the available good land is now under more or less of cultivation. This increased production which is going on, partly obtained by greater concentration of crops and massing of one kind together, accompanied by a properly worked out rotation of crops, partly by more or better manuring, and partly in other ways, is tending to make tropical cultivation as a whole more susceptible to disease, and this alone requires much research as to its causes and methods of prevention. One sometimes hears the opinion expressed that as time goes on less research may be required in connection with tropical agriculture, but this is not our view, though it is not unlikely that in the future research may follow lines that are as yet only faintly indicated, if not even totally unexpected. Some lines which it will have to follow in the near future are rapidly becoming clear; for example, research in ordinary agricultural economics is obviously very much required, as pointed out in the report of the Economics Committee of the Conference. But at the same time it is there pointed out that at present there is no place where the necessary training can be satisfactorily acquired.

The reports of the Committees upon Fruit Preservation and Transport, Animal Nutrition, and Dairying, though they contain much matter of importance, are of comparatively little interest to workers with cotton, but the reports of one or two of the other committees require a word or two of special comment. The Entomological Committee, for example, calls attention to the desirability of holding occasional conferences elsewhere than in London, and to the need of travelling fellowships in Entomology. It is also of opinion that more attention should be paid to the biological control of insect pests—*i.e.*, control by the encouragement (and introduction where necessary and feasible) of those parasitic and other insects which are definitely harmful to the pests concerned. Finally, there are pointed out the facilities offered by the publication of the (central) *Review of Applied Entomology*, issued by the Bureau of Entomology, for the dissemination of early notice of the outbreak of injurious pests.

The report of the Committee on Soils and Fertilizers deals with the desirability of a Soils Bureau to collect and collate information, suggesting that at the same time it might organize soil surveys and other investigations, arrange for interchange of officers or their visits to other countries, and other matters.

The whole Conference is an expression of much good and conscientious work, which, with the increased good fellowship due to meeting, travelling, working together, and visiting the great centres of agricultural work in this country, should result in great benefit to the cause of agriculture in the Empire, and especially in its tropical portions.

# SECOND REPORT ON COTTON FERTILIZER EXPERIMENTS IN THE UNION OF SOUTH AFRICA

THE following is a summary of a report received from Mr. Pieter Koch, the Principal Field Husbandry Officer, Department of Agriculture, South Africa.

As the original is somewhat long, and deals in detail with a great amount of technical matter that is chiefly of interest in the local conditions of the country in which the experiments were carried on, or to other technical students of similar work elsewhere, we have judged it better to attempt to give the principal points of the work, so far as it has yet gone.

The first report (June 10, 1926), which we have not seen, dealt with the general plan of the experiments, their control, the kind and amount of fertilizers to be used, selection of sites, methods of taking soil samples, and the like. No result of any pickings had at that time come to hand. The present report deals with the first and second seasons of the work, which it was decided should be continued for four seasons.

The experiments, which are being carried on with the aid of various selected farmers and others, are conducted upon small plots of $\frac{1}{10}$ acre, arranged as follows (titles explained below):

| | | | |
|---|---|---|---|
| Super | Slag | Slag 2 | Check |
| Super 2 | Slag 2 | Check | Rock 2 |
| Super 3 | Check | Slag 2.2 | Rock 2.2 |
| Check | Slag 3 | Slag 2.3 | Rock 2.3 |

Same again.
Same again.
Same again.

Thus a bed of sixteen by four plots is constructed. A space of 7 feet is cleared between the plots, and one of 15 feet between the series of plots. The whole experiment is surrounded by cotton plants, at least twelve rows along the sides, and the rows continued for an equal distance at the ends.

The key to the foregoing table is as follows:

| | |
|---|---|
| Super | Light or half-normal dressing of superphosphate. |
| Super 2 | Normal dressing of superphosphate. |
| Super 3 | Heavy or double normal dressing of superphosphate. |
| Slag | Light or half-normal dressing of basic slag. |
| Slag 2 | Normal. |
| Slag 3 | Heavy or double normal. |
| Slag 2.2 | Normal dressing of basic slag every alternate year. |
| Slag 2.3 | Normal dressing of basic slag every third year. |
| Rock 2.2 | Normal dressing of rock phosphate every alternate year. |
| Rock 2.3 | Normal dressing of rock phosphate every third year. |

The general programme of the experiments was thus well thought out and arranged, and it is very unfortunate that so large a number of them should be described as having failed more or less completely, on account usually of drought. Some gave no yield at all, others so little that the results were valueless from the point of view with which the experiments were being carried on. One farm, for example, gave 113 lbs. of seed cotton from 4 acres of experiment. In nearly all cases the fields were very uneven and patchy.

One of the best results was obtained upon the Government Tobacco and Cotton Station at Rustenburg. In the season 1925-26, the yields of the plots of $\frac{1}{40}$ acre varied very considerably according to the treatment received, and the following interesting average yields were shown:

| Superphosphate: | *Average Yield of Seed Cotton (Four Plots) in Lbs. per Acre.* |
|---|---|
| 100 lbs. per acre | 474·0 lbs. |
| 200 „ „ | 659·6 „ |
| 400 „ „ | 976 0 „ |
| Check plots | 236·4 „ |
| **Basic Slag:** | |
| 128 lbs. per acre | 369·2 lbs. |
| 256 „ „ | 418·0 „ |
| 512 „ „ | 681·2 „ |
| Check plots | 236·4 „ |

The above figures, of course, require statistical treatment after, for instance, the methods described by Yule and Engledow in this Review for April and July, 1926, but the results are none the less significant.

In the following season, 1926-27, these experiments were repeated, and with results not unlike those of the first season. It would lead too far to go into detail here. The drought was very severe, and low yields were obtained, but again the application of the manures increased the proportionate yield very considerably. It is expected that during the next few years this experiment will yield very interesting and valuable results, especially as the effect of allowing a year or two between dressings will then be evident.

In another experiment which climatic conditions, though very unkind, allowed to come to more or less of a conclusion, the increase in yield only amounted to a very few lbs. per acre, or even was a minus quantity. But as this experiment had only had one year's trial, these results may prove illusory. A third experiment, however, also gave results somewhat similar to these, so that it remains to be determined whether these results are really significant or not, or whether they were so interfered with by abnormal conditions of climate that they have no significance.

The work is to be continued in the present season.

# COTTON STATISTICS

BY

JOHN A. TODD, M.A., B.L.

In the issue of April, 1927, we wrote: " It seems desirable that, as these statistics are now becoming a regular series, they should be arranged in such a way that the same statistics appear each year as nearly as possible on the same date." This arrangement has been worked out during the past year, and the tables as they will appear regularly in future years are now as follows:

January: Consumption and Stocks.

April: World's Crops, with details of American and Egyptian.

July: Indian Crop details and Smaller Crops. (The Corporation's compilation of Empire crop figures also appears in this issue.)

October: Prices.

## WORLD'S CROPS, 1927-28

*World's Crops.*—The total world's supply for the season 1927–28 shows a substantial reduction, for the first time since 1921–22. This is mainly due to the reduction of over 5 millions in the American crop, but there is also a reduction of nearly half a million bales in Egyptian. The final forecast for India, however, shows an increase of about half a million, which is not likely to be much changed by the " supplementary " figures, and the preliminary figures for China indicate an increase.

*American Crop.* — The outstanding feature of the American statistics this year has been the extraordinary accuracy of the Government crop forecasts. The August figure of 13,492,000 bales was very much less than the trade had been expecting, but was still further reduced to 12,692,000 bales on September 1. From then till December the monthly figures were 12,678,000, 12,842,000, and 12,789,000, and present indications point to very little alteration in the final result. No final estimate is available for linters, but up to date the figures for this year are running about 5½ per cent. less than last year. Our estimate of a million may, therefore prove to be a little under the mark. This comparatively heavy production of linters is remarkable, and may be connected with the increased consumption of linters for the production of cellulose, which in America finds many uses in the chemical industries quite apart from artificial silk.

As will be seen from Table II., the smaller crop in 1927 was only partly due to reduced acreage, the average yield being also reduced from 182·6 to 152·3 lbs. This was largely due to the reappearance of the boll weevil, which creates a very unsatisfactory position. The history of the last seven years may be summed up as three very bad weevil years (1921–23), three years of greatly reduced weevil damage (1924–26), and now a year of substantial damage which puts 1927 just about half-way between the two extremes, the average yield for the seven years being 150·9 lbs. Recalling the theory published some time ago by Mr. J. A. Becker, of the Bureau of Agricultural Economics in the Department of Agriculture, Washington, that the weevil was apparently developing a tendency to run in cycles, the question arises whether this is the beginning of another series of bad weevil years. Our own belief, however, is that weevil damage is mainly the result of the weather conditions, and we see no reason to put much faith in the idea of a three years' cycle there.

*Egyptian Crop.*—A good deal of doubt has been thrown on the Egyptian statistics by the fact that the 1926 crop, according to the Alexandria General Produce Association's figures of arrivals and the Government figures of acreage, apparently shows an average yield of 4·84 kantars per feddan. As this would be the highest yield in modern times by a long way, it was at first suggested that the Government's acreage figure was too small; but latterly an alternative explanation has been put forward, that the arrivals during the 1926–27 season contained a large quantity that had been carried over up-country from the previous crop. This figure had been put at about 500,000 kantars, but we have recently been informed by the Statistical Department of the Ministry of Agriculture that it was a million kantars. This would make the figures for 1926 much more credible, reducing the yield to 4·29, but as a million kantars would require to be added to the 1925 crop, which was already record breaking at 7,965,000 kantars, it only shifts the difficulty back a year earlier. The same difficulty arose during the seasons 1920 to 1922, as given in our Egyptian table in the issue of January, 1925. This season the Egyptian Government have begun to publish periodical returns of the actual ginnings which will be of great value in checking such discrepancies in future.

## TABLE I.—THE WORLD'S COTTON CROPS, 1902-27.

BALES OF 500 LBS. (APPROXIMATELY). 000'S OMITTED.

| | *America.* | | *Per Cent. of World Total.* | *India.** | *Egypt.* | *Russia.* | *China.* | *Others* | *Total.* |
|---|---|---|---|---|---|---|---|---|---|
| | *Lint.* | *Linters.* | | | | | | | |
| 1902–03 | 10,631 | 196 | 63 | 3,367 | 1,168 | 342 | 800 | 801 | 17,305 |
| 1903–04 | 9,851 | 195 | 61 | 3,161 | 1,302 | 477 | 800 | 751 | 16,537 |
| 1904–05 | 13,438 | 242 | 66 | 3,791 | 1,263 | 536 | 756 | 803 | 20,829 |
| 1905–06 | 10,575 | 230 | 61 | 3,416 | 1,192 | 604 | 788 | 938 | 17,743 |
| 1906–07 | 13,274 | 322 | 60 | 4,934 | 1,390 | 759 | 806 | 1,027 | 22,512 |
| 1907–08 | 11,107 | 268 | 62 | 3,122 | 1,447 | 664 | 875 | 950 | 18,433 |
| 1908–09 | 13,242 | 345 | 64 | 3,692 | 1,150 | 685 | 1,000 | 971 | 21,085 |
| 1909–10 | 10,005 | 310 | 54 | 4,719 | 1,000 | 663 | 1,419 | 950 | 19,066 |
| 1910–11 | 11,609 | 397 | 55 | 3,889 | 1,515 | 879 | 2,589 | 968 | 21,846 |
| 1911–12 | 15,693 | 558 | 64 | 3,288 | 1,485 | 873 | 2,552 | 1,058 | 25,507 |
| 1912–13 | 13,703 | 610 | 58 | 4,610 | 1,507 | 892 | 2,298 | 1,160 | 24,780 |
| 1913–14 | 14,156 | 639 | 57 | 5,066 | 1,537 | 980 | 2,303 | 1,287 | 25,968 |
| 1914–15 | 16,135 | 857 | 60 | 5,209 | 1,298 | 1,164 | 2,363 | 1,154 | 28,180 |
| 1915–16 | 11,192 | 931 | 57 | 3,738 | 961 | 1,407 | 2,057 | 984 | 21,270 |
| 1916–17 | 11,450 | 1,331 | 58 | 4,489 | 1,022 | 1,110 | 1,714 | 1,027 | 21,143 |
| 1917–18 | 11,302 | 1,126 | 59 | 4,000 | 1,262 | 603 | 1,863 | 1,086 | 21,242 |
| 1918–19 | 12,040 | 930 | 59 | 3,972 | 964 | 420 | 2,203 | 1,298 | 21,827 |
| 1919–20 | 11,421 | 608 | 53 | 5,796 | 1,114 | 274 | 1,914 | 1,485 | 22,612 |
| 1920–21 | 13,440 | 440 | 64 | 3,600 | 1,206 | 121 | 1,667 | 1,406 | 21,880 |
| 1921–22 | 7,954 | 397 | 51 | 4,485 | 972 | 57 | 1,263 | 1,311 | 16,439 |
| 1922–23 | 9,762 | 608 | 52 | 5,073 | 1,243 | 50 | 1,884 | 1,500 | 20,120 |
| 1923–24 | 10,140 | 668 | 52 | 5,161 | 1,306 | 214 | 1,744 | 1,744 | 20,977 |
| 1924–25 | 13,628 | 897 | 55 | 6,088 | 1,455 | 466 | 1,882 | 2,065 | 26,481 |
| 1925–26 | 16,104 | 1,115 | 58 | 6,250 | 1,593 | 715 | 1,796 | 2,148 | 29,721 |
| 1926–27 | 17,977 | 1,158 | 63 | 5,003 | 1,727 | 786 | 1,483 | 2,203 | 30,337 |
| 1927–28 | *12,789* | *1,000* | *55* | *5,480* | *1,280* | *860* | *1,900* | *2,000* | *25,309* |

* 400 lb. bales. Estimates in italics.

## TABLE II.—AMERICAN ACREAGE, CROP YIELD PER ACRE, AND PRICE, 1911–1927.

| *Season.* | *Acreage Harvested* (000's). | *Crop (Running Bales, 000's).* | | | *Average Yield* (*Lbs. per Acre*) (*Ex Linters*). | *Average Price Middling* (*Pence per Lb.*). |
|---|---|---|---|---|---|---|
| | | *Cotton.* | *Linters.* | *Total.* | | |
| 1911–12 | 36,045 | 15,553 | 556 | 16,109 | 207·7 | 6·09 |
| 1912–13 | 34,283 | 13,489 | 602 | 14,091 | 190·9 | 6·76 |
| 1913–14 | 37,089 | 13,983 | 631 | 14,614 | 182·0 | 7·26 |
| 1914–15 | 36,832 | 15,906 | 832 | 16,738 | 209·2 | 5·22 |
| 1915–16 | 31,412 | 11,068 | 945 | 12,013 | 170·3 | 7·51 |
| 1916–17 | 34,985 | 11,364 | 1,300 | 12,664 | 156·6 | 12·33 |
| 1917–18 | 33,841 | 11,248 | 1,096 | 12,345 | 159·7 | 21·68 |
| 1918–19 | 36,008 | 11,906 | 910 | 12,817 | 159·6 | 19·73 |
| 1919–20 | 33,566 | 11,326 | 595 | 11,921 | 161·5 | 25·31 |
| 1920–21 | 35,878 | 13,271 | 429 | 13,700 | 178·4 | 11·89 |
| 1921–22 | 30,509 | 7,978 | 382 | 8,360 | 124·5 | 11·37 |
| 1922–23 | 33,036 | 9,729 | 591 | 10,320 | 141·5 | 14·92 |
| 1923–24 | 37,123 | 10,171 | 640 | 10,811 | 130·6 | 17·66 |
| 1924–25 | 41,360 | 13,639 | 858 | 14,497 | 157·6 | 13·76 |
| 1925–26 | 46,053 | 16,123 | 1,044 | 17,167 | 167·2 | 10·77 |
| 1926–27 | 47,087 | 17,755 | 1,042 | 18,977 | 182·6 | 8·15 |
| 1927–28 | 40,168 | *12,789** | — | — | 152·3 | — |

* December estimate.

## TABLE III.—EGYPTIAN AREA, CROP, YIELD, AND PRICE, 1914–27

| *Season.* | *Area. Feddans.* 000's. | *Crop. Kantars.* 000's. | *Average Yield per Feddan* (*Kantars*). | *Season's Average Prices.* | |
|---|---|---|---|---|---|
| | | | | *F. G. F. Brown. Pence per Lb.* | *Premium over American Middling* (*per Cent.*). |
| 1914–15 .. | 1,755 | 6,490 | 3·70 | 7·34 | 40 |
| 1915–16 .. | 1,186 | 4,806 | 4·06 | 10·42 | 39 |
| 1916–17 .. | 1,656 | 5,111 | 3·10 | 21·56 | 71 |
| | | | | *Sakel.* | |
| 1917–18 .. | 1,677 | 6,308 | 3·75 | 30·97 | 43 |
| 1918–19 .. | 1,316 | 4,821 | 3·66 | 27·85 | 41 |
| 1919–20 .. | 1,574 | 5,572 | 3·54 | 60·34 | 139 |
| 1920–21 .. | 1,828 | 6,030 | 3·30 | 30·24 | 154 |
| 1921–22 .. | 1,292 | 4,858 | 3·76 | 19·75 | 74 |
| 1922–23 .. | 1,801 | 6,213 | 3·45 | 17·29 | 16 |
| 1923–24 .. | 1,715 | 6,531 | 3·81 | 21·55 | 22 |
| 1924–25 .. | 1,788 | 7,274 | 4·07 | 29·82 | 116 |
| 1925–26 .. | 1,924 | 7,965 | 4·14 | 20·05 | 86 |
| 1926–27 .. | 1,786 | 8,635* | 4·84 | 15·39 | 88 |
| 1927–28 .. | 1,516 | *6,400*† | *4·24* | — | — |

* The Government's final estimate was 7,652,190 kantars, the difference being the carry over up-country (see p. 169).

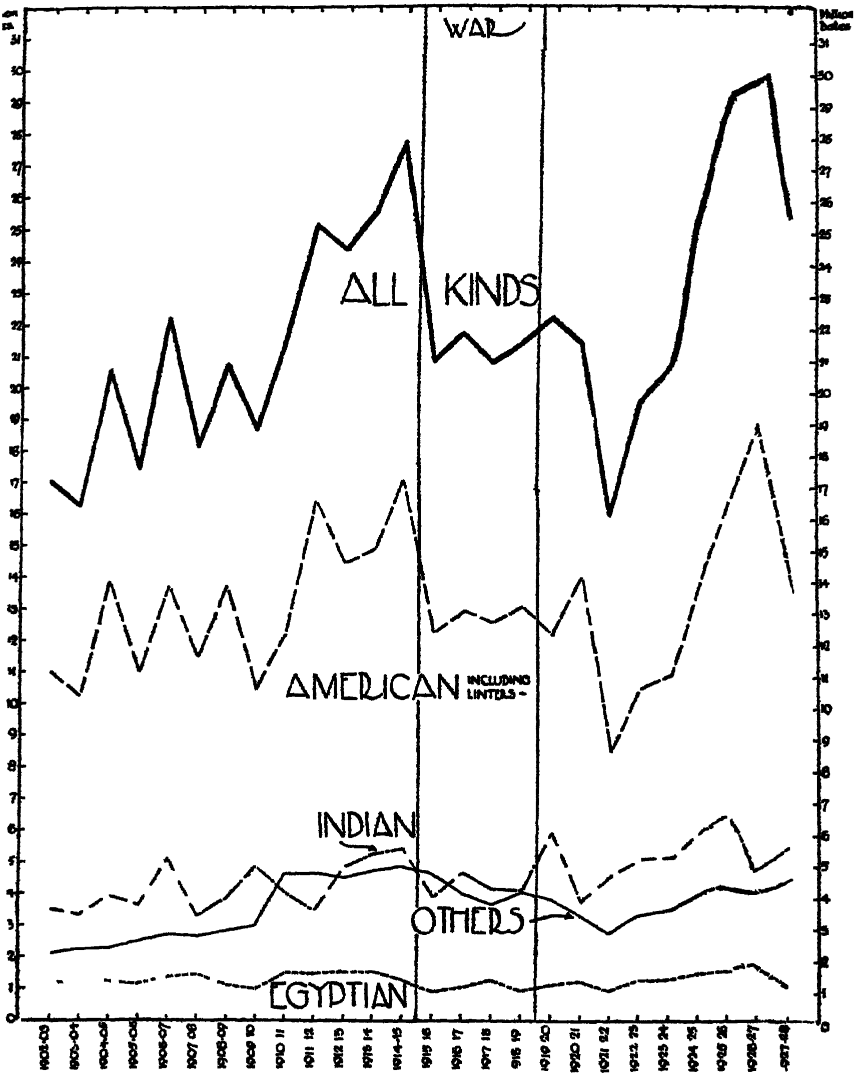
† A. G. P. A. November estimate.

## TABLE IV.—EGYPTIAN CROP: AREA BY VARIETIES.

| | 1913. | 1914. | 1918. | 1919. | 1920. | 1921. | 1922. | 1923. | 1924. | 1925. | 1926. | 1927. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sakel .. .. | 247,292 | 394,403 | 952,481 | 1,146,443 | 1,270,481 | 995,479 | 1,358,162 | 1,255,000 | 872,624 | 1,128,946 | 981,783 | 795,740 |
| Per cent. | 14·4 | 22·4 | 72·5 | 72·9 | 69·5 | 77·0 | 75·4 | 73·2 | 48·8 | 58·8 | 55·0 | 52·5 |
| Ashmouni .. | 356,485 | 353,882 | 273,936 | 334,160 | 283,906 | 170,514 | 276,193 | 310,150 | 796,362 | 270,842 | 667,474 | 599,149 |
| Per cent. .. | 20·7 | 20·2 | 20·8 | 21·3 | 15·5 | 13·2 | 15·3 | 18·1 | 44·5 | 14·1 | 37·4 | 39·5 |
| Zagora .. | — | — | — | — | 97,612 | 92,536 | 126,541 | 102,390 | | 388,578 | | |
| Per cent. .. | — | — | — | — | 5·3 | 7·2 | 7·1 | 6·0 | | 20·2 | | |
| Pilion .. .. | — | — | — | — | — | 319 | 20 | * | 49,960 | 72,799 | 102,394 | 74,451 |
| Per cent. .. | — | — | — | — | — | 0·02 | — | — | 2·8 | 3·7 | 5·7 | 4·9 |
| Afifi .. .. | 623,737 | 467,350 | 36,240 | 35,145 | 44,048 | 6,771 | 8,202 | 6,050 | 22,271 | 8,384 | 4,234 | 4,261 |
| Per cent. .. | 36·3 | 26·6 | 2·7 | 2·2 | 2·4 | 0·5 | 0·5 | 0·3 | 1·3 | 0·4 | 0·2 | 0·3 |
| Assili .. .. | 65,958 | 134,104 | 20,736 | 21,003 | 30,051 | 5,839 | 7,863 | 7,820 | | | | |
| Per cent. .. | 3·8 | 7·7 | 1·6 | 1·3 | 1·6 | 0·45 | 0·4 | 0·5 | | | | |
| Abassi .. .. | 37,383 | 12,281 | 4,871 | 3,718 | 12,558 | 1,267 | 2,274 | * | 46,626 | 54,833 | 29,817 | 42,598 |
| Per cent. .. | 2·2 | 0·7 | 0·4 | 0·2 | 0·7 | 0·1 | 0·2 | — | 2·6 | 2·8 | 1·7 | 2·8 |
| Jannovitch | 173,439 | 127,531 | 223 | 97 | 2,087 | 300 | 225 | * | | | | |
| Per cent. .. | 10·1 | 7·3 | 0·02 | — | 0·1 | 0·02 | 0·02 | — | | | | |
| Nubari .. | 201,137 | 261,775 | 21,587 | 23,611 | 37,320 | 8,645 | 11,090 | 10,660 | | | | |
| Per cent. .. | 11·7 | 14·9 | 1·6 | 1·5 | 2·0 | 0·7 | 0·6 | 0·6 | | | | |
| Others .. | 17,663 | 3,944 | 5,498 | 9,485 | 49,787 | 10,208 | 10,273 | 23,080 | | | | |
| Per cent. .. | 1·0 | 0·2 | 0·4 | 0·6 | 2·7 | 0·8 | 0·5 | 1·3 | | | | |
| Totals .. | 1,723,094 | 1,755,270 | 1,315,572 | 1,573,662 | 1,827,870 | 1,291,878 | 1,800,843 | 1,715,150 | 1,787,843 | 1,924,382 | 1,785,702 | 1,516,199 |

* Included in others.

# THE WORLD'S COTTON CROPS 1902-27



# NOTES ON CURRENT LITERATURE

## *COTTON IN INDIA.*

185. **Indian Central Cotton Committee.** From the press communiqué of the sixteenth meeting of the Committee held on December 12 last, we learn that one of the chief matters touched upon by the President, Dr. Clouston, in his opening speech, was the establishment of "one-variety zones," but it was considered that this would meet with much difficulty in many parts of India, though progress had been made by the introduction of the Cotton Transport Act in some regions.

186. **Indian Central Cotton Committee.** In the *Ann. Rpt. for the year ended August* 31, 1927, it is stated that one of the most striking features of the year's work is the development of research work financed by the Committee. Other features have been increased attention to the improvement of cotton marketing and to the checking of abuses. The Committee has also given considerable attention to the prevention of the introduction of foreign insect pests and diseases of cotton, and details connected with the enforcement of the restrictions on the importation of American cotton have occupied a considerable portion of the time of the Committee and of its staff. Much work has been done in connection with the Cotton Transport Act, the Cotton Ginning and Pressing Factories Act, and the improvement of cotton statistics. In Appendix X. an account is given of the progress made in the introduction of improved varieties of cotton in various provinces.

187. **Cotton Industry in India: History.** By M. P. Gandhi. (*Indian Text. J.*, 1926, **36**, 137, and 1927, **38**, 63. Abstr. from *Summ. Curr. Lit.*, viii., **2**, 1928, M. 2.) A reproduction of a prize essay dealing at length with the history of the textile industry in India. The cotton industry existed in India as early as 800 B.C.

188. **Maintenance of Purity of the Improved Cottons.** By R. Prasada. (*Allahabad: United Prov. Dpt. Agr.*, 1927. Abstr. from *Exp. Sta. Rec.* 57, 7, 1927, p. 630.) The method suggested provides that improved seed from the research station be multiplied and rogued on seed farms and on farms of controlled cultivators, respectively, before turning it over to the cotton grower.

189. **Cotton-Growing in the Punjab.** From the *Rpt. of the Dpt. of Agr. for the year ended 30th June*, 1926, which has recently been received, we learn that on the whole the cotton crop for the year was only fair, mainly due to lack of rain at the end of August and during September, and to the shortage of canal water in the latter month. The area planted to cotton (2,701,800 acres) was the greatest ever grown in the Punjab. The 289-F. variety of cotton is generally considered the most successful type yet evolved.

During the year investigations were carried out into the life histories of Pink Bollworm and Spotted Bollworms (*Earias insulana* and *E. fabia*). A new species of Earias was found near Lyallpur feeding on *Corchorus acutangulus*, *C. trilocularis*, and *C. antichorus*, which are wild plants of the jute family.

Research work on the Jassid problem and into the habits of the Cotton White Weevil (*Myllocerus maculosus*) was continued by the two research students appointed by the Indian Central Cotton Committee.

190. TECHNOLOGICAL REPORTS ON STANDARD INDIAN COTTONS, 1927. By A. J. Turner. (Abstr. from *Bull. No.* 11, *Tech. Ser.* 6, Indian Central Cotton Committee, 1927.) The present edition of Technological Reports on Standard Indian Cottons includes the results of the tests on the standard cottons of the 1926-27 season, in addition to those of the three preceding seasons, published in *Bulletin* No. 7, Tech. Ser. No. 3, May, 1927. Two new standard cottons, Wagad 4 and Wagad 8—representing the Dholleras crop—have now been added to the series; the results for these cottons are given for the seasons 1925-26 and 1926-27.

A number of other new features have been incorporated in the present bulletin. Various agricultural details are now given showing for each cotton its botanical species, its relation to the commercial crop of the district, the conditions of its growth, its yield, and the area under cultivation. Certain fibre measurements, not previously made on the standard cottons, have now been made on the cottons of the 1926-27 season; the additional characters measured are the fibre-strength, the fibre-weight, and the fibre-rigidity. A table has been included to show in summary form the fibre-properties of the 1926-27 cottons; although, as pointed out in the preface to the previous edition, there are a number of reasons for preferring English units in the statement of cotton properties, the opportunity has been taken to present in this summary table the values of the fibre properties not only in English units, but also in metric units, for the convenience of those who prefer the latter. Attention may also be directed to the fact that the cottons of the 1926-27 season have been spun at a higher speed than those of previous seasons, and that new methods have been introduced in the determination of yarn twist and single thread strength and extension. In order to make room for the results of the tests on the 1926-27 cottons it has been found necessary to omit the results for the 2-lb. samples of the 1923-24 (or 1924-25) cottons; the latter results have been given in the two previous editions of this bulletin.

The section of the introductory note devoted to a general discussion of the results has been considerably expanded so as to include a discussion of (1) the characteristics of the standard Indian cottons; (2) the seasonal variation displayed by these cottons; and (3) the relation between fibre characters and spinning value.

191. BOMBAY INDUSTRIES: THE COTTON MILL. Edited by S. M. Rutnagur. (Pubd. by the *Indian Textile Journal*. Price Rs. 20. Abstr. in *J. of Text. Inst.*, xviii., 11, 1927, p. 240.)

192. INSTITUTE OF PLANT INDUSTRY, INDORE. (Abstr. from the *Ann. Rpt. for year ended 30th June*, 1927.) "*Plant-breeding Work:* Collections of unit species of indigenous cottons have been obtained from various Departments of Agriculture in India, and these were grown during the year under report, and their various field characters were noted. Sufficient numbers of selfed bolls were obtained from each of these cultures to enable all the species to be grown this season for further study. The isolation and study of these unit species will form the basis for the work of classifying the various species and varieties of cotton found on the black soils. The practical bearing of such work is to be looked for in the possibility of isolating useful types for distribution.

"Single plant selections from the isolated constituents of the Malwi mixture grown in 1925-26 were studied critically in the field, and their lint characters were examined. This work is directed towards obtaining a higher-yielding, earlier, and better-stapled cotton for the Central India tract. Further selections were made for cultivation and study in the coming season.

"Selections were made from the mixed crops of Bani and Roseum cottons, and these are being studied with a view to isolating the various constituents of the mixtures.

"A commencement has been made during the year under review of growing samples of Herbaceum and Hirsutum cottons, received from different parts of India and from abroad, under both irrigated and dry conditions of cultivation. This will enable these varieties to be studied in detail, and the optimum requirements for their cultivation in Central India will be worked out.

"Much valuable information was collected with regard to the root development, the relations of the root system to the soil character, and the influence of environmental factors on growth of many of the different cottons grown on the plant-breeding plots."

193. LABOUR IN THE INDIAN TEXTILE INDUSTRIES. By Lady Chatterjee. (*Hosiery Tr. J.*, 1927, 34, p. 404. Abstr. from *Jour. Text. Inst.*, xviii., 12, 1927, p. A431.) Describes the improvements that have been made in textile factories since the passing of the Indian Factories Act of 1922 and the Workmen's Compensation Act of 1923. Wages are paid in some cases monthly, ten or twelve days in arrears, and in others weekly, seven days in arrears. Workers are often housed in barracks, where four or five families share one small room. In Bombay there is some provision made for the care of married women. The inefficiency of the Indian worker is primarily due to lack of education. No welfare centres or recreation are, as yet, provided.

194. BOMBAY COTTON ANNUAL, 1926-1927, No. 8. The usual authoritative compendium of all matters relating to every branch of the Cotton Trade. It contains statistical tables of Crops, Exports, Imports, Prices, Stocks, Consumption, Government Notifications, etc., and is designed to meet the requirements of all who are interested in the production, distribution, and consumption of Indian cotton.

## *COTTON IN THE EMPIRE (EXCLUDING INDIA).*

195. LAND TENURE AND AGRICULTURAL PRODUCTION IN THE TROPICS. By H. Martin Leake. (Pubd. by W. Heffer and Sons, Ltd., Cambridge. Price 7s. 6d.) This is an important book, with a wide bearing upon the future of agriculture in the tropics, and indicates a line of solution of the many difficult problems that lie before the tropical administrator and the scientific agriculturist, a line which differs in many respects from those at present pursued. The book, while not of the easiest to read, is one that no one interested in such matters can afford to neglect. The author has been so kind as to supply the following abstract:

In tropical countries inhabited by primitive races, ideas regarding ownership of land are frequently nebulous, but usually communal ownership in some form is found. A pressure of population on the land has not raised the question in acute form, and production limited to supplying local needs is met, while large areas remain in their virgin condition. To this primitive organization civilization, by its increasing demand for tropical produce, and by the development of lines of communication, has administered a rude shock. The demand is now for production beyond the immediate local requirements.

To meet these demands certain conditions are essential: security, access to markets, capital to develop the land, and labour. The provision of the two former is clearly the function of Government. Labour, ultimately, is provided by the indigenous population. It is less easy to suggest the source of capital, mainly because capital requirements are so diverse. The amount of capital to be employed will depend on climatic conditions; in dry tracts, where extensive irrigation works are necessary, it will be large. It will also depend on the nature of the crop; crops like cacao and coconut, taking long to mature, and crops like cane, involving heavy expenditure in preparation for the market, also involve large capital expenditure. For short-season crops like cotton, on the contrary, relatively little capital is required.

The modern demand, which can only be met by the employment of external capital, unfortunately but inevitably leads to land alienation, and to the formation of a landless labouring community, without share in the general welfare other than a fixed wage. Sound evolution would appear to indicate the desirability of the inclusion of labour as a member of a triple partnership, with Government supplying security and the means of communication, and a "landlord" supplying the capital. Where the unit of capital is large external, capital is inevitable, but there exists a large field for a native "landlord." Equitable division of the reward, including the "unearned increment" in land values, is achieved by a land tax fixed at short intervals (temporary settlements), and by the "landlord" acting as agent for the disposal of the produce of the estate. The key to success lies, as with the metayer system of the Continent, in the active co-operation of the "landlord." Such a native "landlord" is to be found among the chiefs and sub-chiefs, and the organization is an evolutionary development of the tribal system. In the author's view such a system is more suited to meet the process of intense development now in being than a system of small holdings, which requires co-operative organization for the provision of capital.

But if development is to take place on these lines, the "landlord" class, which hardly exists at the present time, must be educated to serve its function, and the provision of two distinct types of education is necessary: the first to train that section of the native community which occupies the position of tenant, and earns its living by labour in the field, in the art of modern agricultural practice, the second to educate the smaller, but more responsible, section in the higher principles of agriculture, including in that term the correct employment of capital and the requirements of markets.

**196.** Tropical Agricultural Research in the Empire, with Special Reference to Cacao, Sugar Cane, Cotton, and Palms. By Dr. C. A. Barber. (Pubd. by H.M. Stationery Office. Price 1s. 6d.) This is a carefully thought out article upon a subject that is of daily increasing importance, and will repay study. Dr. Barber begins by pointing out that indigenous agriculture in various parts of the tropics still shows many of the stages through which such agriculture has probably passed before reaching such a condition as is shown, for example, in parts of India. The problem of assisting it varies with the stage of progress reached. European agriculture in the tropics, on the other hand, exhibits an almost completely different set of problems, the solution of which need not necessarily be of great advantage to general agriculture in the bulk of the country concerned. Of recent years the solution of these problems is coming more and more to be handed over to special departments, kept up by the planters themselves, as was first done in Java and Hawaii.

Dr. Barber then points out the wide significance of "agriculture" in the tropics, describes what is meant by research, warns people against an equipment that is too purely of "laboratory" type without sufficient field experience, and goes on to consider the great increase now being shown in the demand for tropical products (a subject dealt with above on p. 16). He then states his agreement with the idea that is now gaining ground of "one-crop specialists," and goes on to deal with four selected crops, of which cotton is one. He next passes to the specialized knowledge required, and the various problems connected with diseases, breeding of improved varieties, and the like, that lie before the investigator. The pamphlet will repay careful study.

**197.** ASIA: Cyprus. *Cotton Cultivation.* (Abstr. from the *Ann. Rpt. of the Dir. of Agr. for the Year* 1926, p. 6; recently received.) The cultivation and production of cotton have been considerably increased. The weather was favourable for the crop, and owing to the precautions taken against the Cotton Bollworm considerably less damage was caused by this insect. It is hoped in a short time, by continued attacks on it, to rid the Island of this pest, which has caused such enormous financial loss in Egypt and elsewhere.

The following new varieties of cotton were experimented with at Perivolia, near Larnaca, with good results: Hartsville, Allen's Long Staple, Sunbeam, Brown, Webber, Durango, Triumph, Lone Star; the best varieties, however, were found to be Triumph, Webber, and Brown.

**198.** *Cotton.* (Abstr. from the *Cyprus Agr. Jnl.*, xxii., 4, 1927, p. 122.) In February, 1927, samples of cotton were sent by the Agricultural Department to the Empire Cotton Growing Corporation for spinning tests. The samples were submitted to spinners, and the report received upon the trials is to the effect that "all the Cyprus samples are good and usable cottons." The varieties submitted for test were Sunbeam, Hartsville, Allen's Long Staple, Idalion, Webber, Brown, and Triumph.

**199.** AFRICA: GOLD COAST COLONY. *Cotton Cultivation.* By C. H. Knowles. (Abstr. from *Man. Guar. Coml.*, Special Br. West Afr. Number, November 24, 1927, p. 12.) Cotton-growing has always been an industry in the Gold Coast, and spinning and weaving are still carried on in many localities. Special encouragement was given to cotton-growing by the Government and by the British Cotton Growing Association many years ago, but it has never amounted to an industry of any extent. In British Togoland for the last three years there has been an encouraging development, which is being fostered. A scheme has recently been inaugurated for the development of cotton-growing in the Northern Territories, where at present the people have no export industry, owing principally to lack of cheap transport facilities. Cotton, however, of a suitable kind is able to bear the cost of lorry transport to the railway at Kumasi.

As in other parts of the Gold Coast, the people in the Northern Territories have always grown patches of cotton, hence the development of the industry does not involve learning to cultivate a new crop. New seed of an improved strain has been introduced, and a ginnery provided for at Tamale, the headquarters of the Northern Territories. The people have taken up the matter with enthusiasm. There are certain difficulties to be overcome, but there seems no reason why in course of time cotton-growing should not be a well-established industry over considerable stretches of the Northern Territories.

**200.** NIGERIA. *Cotton Prospects.* (Abstr. from the *Half-yearly Rpt. to the Sept.* 30, 1927, recently received from the Director of Agriculture.) *Northern Provinces: American Cotton.*—Weather conditions on the whole have been distinctly favourable this season, but it is believed that owing to low prices and last season's short food crops, there will be a reduction in the cotton acreage. A notable exception, however, is Southern Katsina, where apparently little or no reduction has been made. It is estimated that some 28,000 bales will be produced in the Northern Provinces this season.

*Southern Provinces: Native Cotton.*—In the Oyo Province there has been a reduction in the area planted to cotton this season, but in other parts there appears to be no change.

**201.** *The Government's Rôle in Tropical Agriculture: Supervision and Guidance for the Native Farmer.* By O. T. Faulkner, Dir. of Agriculture, Nigeria. (Abstr. from *Man. Guar. Coml.*, Special Br. West Afr. Number, Nov. 24, 1927, p. 19.) An interesting description of the activities of the Agricultural Department. In referring to cotton, the reasons are given for the neglect of American cotton by the natives. Efforts have been made to find a superior strain of native cotton which will be suitable for export, and possibly more resistant to disease than the ordinary native cotton. It is believed that success has been achieved in this work, and that a satisfactory cotton has been bred. This will be rapidly multiplied, and there is reason to hope that in a few years a considerable export trade will be built up.

**202.** *Ishan Cottons.* (Abstr. from the *Half-yearly Rpt. to the Sept.* 30, 1927, recently received from the Director of Agriculture.) In the current season (1927-28) efforts are being made to multiply to the maximum possible extent the seed of the two strains of improved indigenous cotton " Improved Ishan A " and " Improved Ishan B." The area planted with the two varieties is approximately 1,336 acres, and up to date they have done very well and are exceptionally free from disease of all kinds. It is hoped that some 350 bales of lint will be obtained, and well over 100 tons of seed fit for sowing. The Department propose to encourage economy in the use of the seed by selling it instead of giving it away like the ordinary seed.

**203.** NYASALAND. (Abstr. from *East Afr.*, vol. iv., 171, 1927, p. 509.) A report from Barclays Bank is to the effect that an optimistic feeling prevails in regard to coming months. Natives are said to be taking a greater interest in cotton, as a result of the fixing of prices by the British Cotton Growing Association, and it is hoped that the native acreage will be increased next season.

**204.** *Cotton Cultivation.* (Abstr. from the *Ann. Rpt. of the Dpt. of Agr.*, 1926, recently received.) The native cotton crop was 2,197 tons of seed cotton in 1926 as compared with 2,909 tons in 1925. Although this reduction in output is disappointing, the production for 1926 is a large increase over the native cotton crop of any previous year with the exception of 1925.

Continued progress has been made by the officers of the Empire Cotton Growing Corporation stationed in the country in their trial of strains and varieties of cotton, and in their experimental work with rotation crops. Seed of the promising new variety " Over the Top " has been multiplied, and arrangements made for ten bulk observation plots scattered throughout the country from Fort Jameson southwards. An important feature of the activities of the Corporation's staff during the year has been the development of an experimental station at Port Herald, where cotton and rotation crops are being grown under conditions comparable with those prevailing on the Lower River—the section of the country where the bulk of the European and native-grown cotton is now produced.

During the year the Cotton Leaf Roller (*Sylepta derogata*, F.) and the Black Leaf Beetle (*Syagrus morio*, Har.) were reported as doing considerable damage in the Chiromo district. Confirmation of the identification of the Pink Bollworm (*Platyedra gossypiella*, Saund.) found in the North Nyasa district was received from the Imperial Bureau of Entomology.

**205.** NORTHERN RHODESIA. *Cotton Experiments.* (Abstr. from the *Rpt. of the Dpt. of Agr.*, 1926, recently received.) In the Experimental Gardens at Chilanga cotton grown on ridged plots under irrigation gave better yields than when planted on the flat. Jassid caused a good deal of trouble on the experimental plots, the only variety showing a high degree of resistance being Cambodia.

**206.** *Possibilities and Problems of Settlement in Northern Rhodesia.* III. By F. Melland. (Abstr. from *East Afr.*, vol. iv., 171, 1927, p. 493.) *Cotton.*—An experiment station has now been established at Mazabuka, and it is hoped that within a few years a cotton of good staple and sufficiently resistant to local troubles will be evolved, which may be grown with a fair amount of confidence during the majority of years. This will provide a genuine rotation crop with maize, the difference that a remunerative rotation crop would make being incalculable.

207. Southern Rhodesia. *Cotton Cultivation.* (Abstr. from the *Rhod. Agr. Jnl.*, xxiv., 11, 1927, p. 1128.) In Southern Rhodesia cotton will probably be planted this season as a rotational crop with maize, the excellent results obtained from previous plantings amply justifying such a course. That cotton can be grown successfully in certain parts of the Colony has been fully proved, but operations must of necessity be restricted until such time as suitable seed is available. There is every reason to believe that before long the plant breeders at Gatooma will succeed in propagating a variety which will meet the country's requirements, and when that time arrives cotton will no doubt occupy a prominent place in the list of crops grown in the Colony. A limited quantity of seed obtained from the Union of South Africa is being distributed to farmers this season, but, as pointed out by Mr. Cameron, no guarantee can be given that it is resistant to jassid attack.

208. Sierra Leone. *Cotton Cultivation.* (Abstr. from *Ann. Rpt. of the Lands and Forests Dpt.*, 1926.) From this Report, recently received, we learn that the results of the trials with Allen's Long Staple Cotton proved disappointing. Propaganda to encourage more extensive cultivation of the crop was therefore modified this year until further experimental work with this and other varieties had been carried out.

In manuring experiments at Binkolo, much the best result, though only at the rate of 289 lb. of seed cotton per acre, was obtained from the plot treated with complete manure and lime.

209. Field Husbandry in South Africa. By Pieter Koch. (Abstr. from the *Sun and Agr. J. of S. Afr.*, Nov., 1927, p. 1077.) *Cotton.*—Mr. Koch states that although the quality of South African cotton is on the whole superior to that of American cotton, there is urgent need for better field husbandry, since until the acre yield is increased, the industry cannot make the progress anticipated. Much is being done to cope with several serious insect pests affecting the cotton plant. Marked progress has been made with the jassid insect, and it is expected that in the near future this trouble will largely be overcome. No preventive has yet been found for the more serious Sudan bollworm. The selection and breeding work which has been in progress at the Rustenburg Experiment Station for the past six years is progressing satisfactorily. The scheme of selecting cotton growers for multiplying the Government-bred seed has been in operation, with good results. During the past season, owing to the serious drought, the cotton breeding work suffered considerably both at the Rustenburg and the Barberton Experiment Stations. The assistance given by the Empire Cotton Growing Corporation since 1924 is being continued, and as a result of a visit from the Director, Sir James Currie, the research work is being still further extended. The help so readily given is of great advantage to the cotton industry in South Africa. The relations between the Department of Agriculture and the Corporation are most cordial, and the spirit of co-operation from both sides is all that can be desired.

210. *The Cotton Situation in South Africa. Some Factors affecting the Market.* By A. R. Pullen. (Abstr. from *The Sun and Agr. Jour. of S. Afr.*, October, 1927, p. 988.) A discussion of the way in which the American crop influences the cotton market, sending prices up and down—a matter which can only be remedied by growing more cotton in other countries.

211. *Cotton Progress and Prospects. The Orange River Cotton Lands.* (Abstr. from the *Sun and Agr. J. of S. Afr.*, November, 1927, p. 1049.) In an interview given to the *Sun and Agr. J. of S. Afr.* Mr. Ingram states that the finest cotton he has seen in South Africa comes from the country lying along the lower reaches of the Orange River from Upington to Kakamas. It is grown on the rich alluvial soil of the river, and gives a beautiful white staple of from $1\frac{1}{16}$ to $1\frac{1}{4}$ inches in

length. The whole area seems to be surprisingly free from the ravages of insect pests, which gives to the Orange River cotton a characteristic all its own, and makes it far superior to cotton grown in other parts of the Union.

212. SUDAN. *Agricultural Reseach.* (Extr. from *Rpt. on the Finances, Administration and Condition of the Sudan in* 1926, p. 36 [Cmd. 2991].) "Agricultural research should perhaps be mentioned in connection with the Government's commercial enterprises, as its results may have a very important bearing on their success. Progress has been made during 1926 with the Government's programme at the Gezira Research Farm near Wad Medani, and the plant-breeding establishment at Shambat. The Sudan Plantations Syndicate and the Empire Cotton Growing Corporation are giving financial assistance to this work. It will be the Government's policy to devote a proportion of its revenue from the Gezira project to research work of this kind."

213. *Gezira Irrigation Scheme: Blue Nile Province.* (Abstr. from *Mnthly Rpt. issued by the Coml. Intell. Branch, Cent. Econ. Board, Sudan,* xxii., 1, 1928, p. 10.) The cotton crop continues to look exceptionally good. Normally at this time of the year (December) it receives a severe check, but this season, owing to favourable climatic conditions, it has continued to grow except on really poor land. Picking has begun, but generally the crop is about a fortnight later than it was last season. This is partly due to late rains which have produced a plant with more vegetative growth than usual. A crop of 4 kantars a feddan would now be a conservative estimate, and certain areas near Hag Abdulla are expected to produce much more than this.

214. *Gezira Research Farm.* (Extr. from *Rpt. on the Finances, Administration, and Condition of the Sudan in* 1926, p. 62. Pubd. 1927. Cmd. 2991.) "The Gezira Research Farm has been extended by the addition of 80 feddans. The experiments in general have been the same as in the previous season, but the increased area has allowed further replication of plots, and has facilitated the fallowing of areas and the sowing of cotton in blocks. In the main the results of experiments in previous seasons have been confirmed. This is particularly so in the case of improvement of yields by feeding stock on the land and by the use of nitrogenous manures. The benefit of a change of seed was further demonstrated by the resulting strong healthy seedlings, which showed good powers of resistance to Blackarm infection. In this connection seed introduced from Tokar was particularly successful. A practical application of this result will be made in the season 1927-28, when a large area of the Gezira will be sown with Tokar seed selected from the present season's crop."

215. *Railways.* (Abstr. from *Rpt. on the Finances, Administration, and Condition of the Sudan in* 1926, p. 56. Pubd. 1927. Cmd. 2991.) The extension of the railway from Kassala to Gedaref was commenced on the 14th December. The orders for the necessary permanent way material, rolling-stock, etc., required were placed in England. The extension of the railway necessitates the construction of a steel girder bridge 1,100 feet long over the River Atbara at Abu Deleig. It is hoped to complete the bridge by June, 1928; in the meantime, however, in order to permit work on railhead to be continued next winter, a temporary bridge will be built. It is expected that the line will reach Gedaref before the end of 1928.

Two survey parties are conducting surveys of possible railway routes in the Nuba Mountains Province between Rahad and Talodi.

216. *Transport.* (Abstr. from *Rpt. on the Finances, Administration, and Condition of the Sudan in* 1926, pp. 45 and 56. Pubd. 1927. Cmd. 2991.) During the last three years road development in the Southern Provinces has increased at a great pace. Thousands of miles of road have been opened to motor traffic in the dry

weather, and there are, at present, about 1,300 motor-cars (including lorries) in use in the Sudan.

The mechanical transport service on the Rejaf-Aba road has been maintained. Eight new Thornycroft six-wheel lorries with two-wheel trailers have been sent up to replace old lorries, and have worked satisfactorily. Owing to the contemplated move from Rejaf to Juba, the provision of proper workshop facilities, offices, etc., for this branch has been delayed, but now that the move has been definitely decided upon the construction of the necessary buildings will be put in hand. A new mechanical transport service running on the Tonga-Talodi road was inaugurated in December in order to bring out cotton, etc., from the interior of the Nuba Mountains Province to the river, and to transport the material for the new ginning factories for Talodi and Kadugli. The fleet consists of ten Thornycroft lorries and trailers similar to those supplied for the Rejaf-Aba road, a 100-h.p. "Hathi" tractor with trailers, and two Ford lorries.

In the experimental section various types of vehicles have been tested as to their capabilities for work in this country. Half-track lorries have not proved a success, and a much improved design is necessary before vehicles so fitted can be regarded as having any degree of reliability. It is clear that such vehicles must be designed as a whole—it seems that it is not feasible to design track mechanism as an accessory to be fitted to standard lorries. The conclusion arrived at as a result of the tests is that, of the types of vehicles now available, the six-wheel lorry appears to be the most suitable for use in this country, and, as indicated above, the six-wheel Thornycroft lorries which have been obtained have proved very satisfactory.

Experiments with cars fitted with a charcoal gas producer have been continued during the year with encouraging results. (*Cf.* vol. iv., pp. 293-4.)

217. TANGANYIKA. *Cotton.* (Abstr. from the *Rpt. of the Dpt. of Agr. for the year ending March* 31, 1927.) For the improvement of cotton in the Mwanza, Tabora, and Bukoba Provinces, it has now been possible to eliminate completely the old seed, and replace it by the stocks of seed multiplied from the variety imported from Uganda. The quantity of seed thus supplied and sown for the 1927 crop reached 675 tons.

In the Rufiji district, in co-operation with non-native planters, the best of the strains of cotton of the local seed-stocks, selected by the Cotton Specialist of the Empire Cotton Growing Corporation, was multiplied for distribution to growers. This selection is designated by the letter "M." The latest reports from the lint from this strain, however, show that it has not maintained its superiority over the first quality lint from the ordinary district seed, and it will be allowed to go back into the district stocks. Notwithstanding the necessity for abandoning this originally multiplied most promising strain—a contingency which was provided against, at the suggestion of the Cotton Specialist, by maintaining the propagation and purity of the remaining promising selections—the work is being pursued. One of the remaining strains, Mp. 9/2, has shown the most promising permanent characteristics in the last two years, and should the report from the Empire Cotton Growing Corporation on the quality of its lint be favourable, the ready means of multiplication that exist will be used rapidly and fully.

Under the head of Marketing Improvement and Extension, it is stated that the cotton market (as distinguished from cotton auction market) system was in operation in the Mwanza Province, and the Morogoro and Lindi areas. This open and continuously competitive system has now been shown to be well adapted and easy of application in areas of large production, and will gradually be extended to other areas as production and competition in these increase. The auction market system, with daily deliveries, was continued as before for the areas of small production.

218. *Tanganyika Territory.* A report received from H.M. Eastern African Dependencies Trade and Information Office on crop conditions in the Territory to the end of January, stated that in most of the districts there had been an increased demand for cotton seed, but that good rains were badly needed.

219. UGANDA. (Abstr. from *East Afr.*, vol. iv., 171, 1927, p. 509.) An average yield of cotton is expected, but the opinion is expressed that next season should witness an increase in production.

220. *The Buganda Raw Cotton Buying Association.* (Abstr. from *East Afr.*, vol. iv., 177, 1928, p. 709.) The Association originated from the meeting of a few Buganda Province ginners to evolve a scheme to eliminate excessive competition for cotton, and to reduce the overhead charges on the industry. The objects of the Association are as follows: (*a*) To establish co-operation amongst ginners in the Uganda Protectorate, and more especially in the Buganda Province; (*b*) to secure joint action amongst ginners in the dealing in and distribution of raw cotton and cotton seed, and the transport of raw cotton, lint cotton, and cotton seed; (*c*) to take such action as the Association may consider necessary or advisable for the preservation and improvement of the quality of Uganda cotton; (*d*) to secure a reduction of the overhead expenses of the ginning industry by the elimination of unnecessary charges; (*e*) to encourage growers of cotton by ensuring them a fair return for their produce, and at the same time to ensure a fair profit to the ginning industry; and (*f*) to establish and enforce rules and regulations and by-laws for the adequate fulfilment of such objects.

221. *N.* 17 *Cotton.* (Abstr. from a report received from H.M. Eastern African Dependencies Trade and Information Office, February 20, 1928.) Seed from this variety is to be distributed for planting throughout the Northern Provinces in 1928. The whole of Busoga District, practically the whole of the Teso and Lango Districts, and some counties of Bugwere District, Eastern Province, will be under N.17 this year, whilst the introduction of this strain into the Buruli County of Mengo District is under consideration.

222. *Cotton Prospects.* The latest report from the Dpt. of Agr. is to the effect that the crop prospects in most of the districts are promising.

223. *Cotton Prospects.* (Abstr. from *Rpt. on the Trade and Commerce of East Africa*, 1926-27 (C. Kemp), recently received from the Dept. of Overseas Trade.) There was at one time considerable apprehension as to the possibility that lower cotton prices might result in decreased acreage, but so far as can be gathered the very heavy fall in the market for raw cotton during the past two years has not been responsible for any appreciable reduction in planting, and present indications are that the acreage under cotton in 1927-28 will be fully up to that of the past two years, and possibly slightly increased.

224. *Transport of Cotton.* (Abstr. from *East Afr.*, iv., 177, 1928, p. 717.) A petition presented to the Uganda Government by cotton ginners, merchants, and middlemen of the Eastern Province protests against the new regulation permitting the transport of seed cotton by buyers. One striking objection cited by the petitioners is that the new rule will necessitate the purchase of 125 motor lorries by the ginneries, which number about twenty-five in the Province, at an estimated total cost of £25,000.

225. EDUCATIONAL NEEDS IN WEST AFRICA: AN AGRICULTURAL VIEW. By G. Howard Jones. (Reprinted from *The Jour. of the Afr. Soc.*, July, 1927.) It is pointed out that, as in other tropical countries, the end of the days of cheap success by inefficient men with inferior products is in sight, and a more highly educated type of agriculturist is becoming necessary. The problem is then

considered from an educationist's point of view, and it is suggested that thorough research is needed along various lines in order to evolve the system of education best suited to the people.

**226.** AUSTRALIA. We have recently received from the Dept. of Overseas Trade a copy of the *Rpt. on the Econ. and Coml. Situation of Australia to June, 1927*, by R. W. Dalton. It is stated under the heading of " Cotton " that considerable interest has recently been shown in cotton-growing mainly as a result of the encouragement of the industry by the fixed advance of 5½d. per lb. for seed cotton of good quality, and by the action of the Australian Cotton Growing Association in establishing modern ginning plants at convenient points.

**227.** QUEENSLAND. *Cotton.* (Abstr. from the *Ann. Rpt. of Dpt. of Agr. and Stock for the year* 1926-1927.) From the report of Mr. Wells, the Cotton Specialist, we learn that the transitional stage in the development of cotton-growing in Queensland has now been entered. Last season was the terminating one under the system of Government guaranteed advances. The marketing arrangements are now controlled by a Pool Board which is responsible for the handling of the crop on its rail delivery, and its financing and disposal. The work of seed cotton and lint grading, and the maintenance and supply of pure seed, is performed by the Department. The present season marks the inauguration of a system of Commonwealth bounties on seed cotton and on cotton yarn manufactured in Australia.

During the year under review the most extreme combination of climatic conditions was experienced since the revival of the cotton industry in Queensland in 1919, and cotton-growing was subjected to a fairly severe test as to its cultivable suitability in the inland regions under heavy rainfall conditions. Results indicate, as a whole, that cotton can be grown with profit in these areas.

The past season has also experienced a series of attacks, of varying degrees of importance, from the following insects: Cutworms, Corn Ear Worm, Pink Bollworm, Harlequin Bug, Cotton Stainers, and False Stainers.

Satisfactory field and laboratory work was carried out at the Callide Cotton Research Station, notwithstanding the weather vagaries. From bulk plantings, despite dryness at critical stages in development, returns varying from 925 to 1,473 lb. of seed cotton per acre were received. The condition of the present season's plots indicates that yields ranging from 703 to 1,708 lb. of seed cotton per acre, with most of the early-planted plots ranging round 1,000 lb., are in prospect. Pure-seed propagation was also continued with satisfactory results. The " bulk selected " breeding plot again produced a good crop averaging per acre 1,224 lb. of seed cotton.

**228.** *Cotton Crop Prospects.* (Abstr. from *Queens. Agr. Jnl.*, xxviii., 5, 1927, p. 456.) The Minister for Agriculture and Stock, Mr. W. Forgan Smith, recently informed the Press that from reports which had been received from the Department field officers, it appeared that the planting conditions over the whole of the Cotton Belt were the best that had been experienced in recent years. Not only had excellent rains fallen, but the standard of the preparation of the seed bed was a decided improvement over that of recent seasons. The experiences of growers, in nearly every district during the past seasons, have demonstrated conclusively that early prepared seed beds are of marked advantage in obtaining an early planting. It also has been demonstrated that early planted crops afford a better insurance of obtaining larger yields. These facts are impressing the growers more forcibly each season, and this past winter has seen most of them endeavouring to prepare their land at the earliest opportunity.

**229.** *Cotton-Growing in Queensland.* Pt. I. By W. G. Wells. (Abstr. from *Queens. Agr. Jour.*, xxviii., 5, 1927, p. 459.) A detailed account given under the following headings: Climate; Rainfall; Soils, suitable and unsuitable; Size of cotton areas; Farm equipment; Preparation of the seed-bed; Depth and number of ploughings; Planting methods; Spacing; Thinning; Picking methods: Forwarding cotton to ginneries; Grading; Ginning; Marketing; Pure Seed supply; One-variety cotton-growing.

**230.** FIJI: *Cotton in Fiji.* By R. R. Anson. (Abstr. from *Trop. Agriculture*, iv., 12, 1927, p. 223.) Deals with the establishing of the industry in the Islands.

**231.** *Cotton Cultivation.* (Abstr. from the *Ann. Rpt. for* 1926, recently received.) Owing to the unfavourable market for Sea Island cotton, the area planted was not as great as it would otherwise have been, and the Government took steps to discourage over-production by not proceeding with the proposed establishment of ginneries on the Ra Coast and on Vanualevu. The Sigatoka ginnery of three units was completed in January, 1927, after many delays resulting from the labour strike in England. Additional storage space was provided at the Lautoka ginnery, but even so congestion occurred, and at times ginning did not keep pace with seed cotton deliveries, some of which had to be refused admission temporarily. In spite of the dry season the crop turned out well, and proved a great boon to those Indians who had lost their maize and rice from drought.

The event of importance was the establishment of an Experimental Station on the Sigatoka river for testing improved strains of Sea Island cotton, and for testing other varieties that may eventually pay better than Sea Island. Experiments were also inaugurated to test the properties of "Izal" as a seed disinfectant against *B. malvacearum.*

*Transport:* The difficulties in transporting cotton are gradually being overcome by the Indian community converting old Ford cars into lorries. There were at one time during the rush some twenty lorries on the roads. Some Indians have been enterprising enough to invest in two-ton lorries. The above is rather a remarkable development, for when the cotton industry was started there was only one 1-ton lorry in the whole of the cotton zone. Incidentally, it has been the means of transporting other kinds of produce, and of opening up feeder roads and tracks to the foothills.

The local shipping companies granted special rates for seed cotton, the cut in freight being nearly equal to a 50 per cent. reduction, which considerably eased the position for the growers along the Ra coast and Ba district.

**232.** WEST INDIES: *Cotton in Grenada.* From the *Grenada Handbook*, 1927, a copy of which has recently been received, we quote the following: "Cotton (Marie Galante) is at present only grown in the principal island in small quantities, but owing to good prices planting of this crop is again increasing. It continues to be the staple of Carriacou, where the present condition of the cotton market and the settlement by Government of a peasant proprietary, combined with the resumption of cultivation of some of the more important estates, should tend to increase the output."

**233.** *Report on Development of Agriculture in the Leeward and Windward Islands and Barbados.* By H. C. Sampson. (Pubd. by H.M. Stationery Office, 1927. Price 6d. net.) Deals among other matters with the cotton-growing industry in the Islands. The following suggestions are made: (1) That the date for the removal and destruction of the old cotton crop in Nevis should be made considerably earlier, in order to afford protection from Pink Bollworm to St. Kitts, where the cotton crop matures much later. (Owing to the close proximity of the Islands, it is considered possible that the Pink Bollworm is blown over from the old crop in Nevis to the ripening crop of St. Kitts.)

(2) That seed selection work on cotton be concentrated at one centre for the Leeward Islands, and that the testing out of selected seed and the multiplying of suitable types be left to the local agricultural officer in each Island.

(3) That varieties of long-staple Upland cotton be tried in Barbados with a view to obtaining a short season heavy yielding type, which will leave a longer close season for the control of Pink Bollworm.

**234.** *St. Vincent.* A note received from the Agricultural Superintendent, on the cotton crop for the quarter ended December 31, is to the effect that the area planted under Sea Island cotton for the season 1927-28 is 3,363 acres, and under Marie Galante cotton 994 acres. In some fields of Sea Island cotton weeding operations were neglected during the early part of the season, with the result that the cotton plants did not make particularly good growth. During October and November heavy rains were experienced, and cotton bolls were in places heavily attacked by soft rot (*Phytopthora*). Towards the end of the year stainers (*Dysdercus*) appeared in places, but were not responsible for material damage.

**235.** *West Indian Notes.* By Sir Francis Watts. (Abstr. from *Trop. Agriculture*, iv., Nos. 10, 11, and 12, 1927.) An interesting series of articles dealing with the crops of the West Indies grown for export. A history of cotton-growing in the Islands is included, and the problems of seed supply and the control of insect pests are dealt with.

**236.** *Report on Development of Agriculture in Trinidad.* By H. C. Sampson. (Pubd. by H.M. Stationery Office, 1927. Price 3d. net.)

**237.** *Report on Development of Agriculture in British Guiana.* By H. C. Sampson. (Pubd. by H.M. Stationery Office, 1927. Price 9d. net.)

## *COTTON IN THE UNITED STATES.*

**238.** VARIETIES OF COTTON FOR THE GULF COASTAL PLAINS OF TEXAS. By D. T. Killough and V. E. Hafner. (*Texas Sta. Bull.*, 354, 1927. Abstr. in *Exp. Sta. Rec.*, lvii., 6, 1927, p. 527.)

**239.** HALF-AND-HALF COTTON. (Abstr. from the *Rpt. on the* 1927 *Journey through the U.S.A. Cotton Belt.* By Arno S. Pearse. *Int. Cot. Bull.*, vi., 21, 1927, p. 40.) The use of Half-and-Half cotton, with its short staple ($\frac{5}{8}$ to $\frac{7}{8}$ inch) but high ginning outturn (40 per cent. against usually 33 per cent.), and good yield per acre, is still very widespread, though perhaps a falling-off may be noticeable. In certain districts, for instance East Texas, this variety proves more remunerative to the farmers than others, and it will be very difficult, therefore, to oust it altogether. As long as it is not mixed with staple cotton, it will not be harmful, as a market exists, especially in the Far East, for this short cotton. Once this Half-and-Half seed has become mixed with other seed it will take many years to remedy the evil, even where the farmers desire to get rid of it.

[*Cf.* Abstracts 53, 303, 527, of vol. iii.]

**240.** RELATION OF LENGTH OF STAPLE TO YIELD AND VALUE PER ACRE OF COTTON IN THE SOUTH-EASTERN STATES. By R. R. Childs. (*Jour. Amer. Soc. Agron.*, 19, No. 8, 1927. Abstr. from *Exp. Sta. Rec.*, lvii., 9, 1927, p. 827.) Data from experiment stations in North Carolina, South Carolina, Georgia, and Alabama, showed that cotton averaging $\frac{7}{8}$ to $\frac{15}{16}$ inch in length of staple returns the highest yields and highest acre values. The decrease in yield as length of staple increases is 15 per cent. for the first $\frac{1}{16}$ above 1 inch, and 6·5 per cent. for each additional $\frac{1}{16}$. Even when one best variety in each group is considered, cottons stapling longer than 1 inch do not yield as high as those with $\frac{15}{16}$ inch staple. Mexican $1\frac{1}{16}$ inches in North Carolina and Acala $1\frac{1}{16}$ inches in Alabama were slightly more profitable, suggesting the need for selection and adaptation of varieties to conditions prevailing in each State.

At the Mississippi Delta Substation staple cottons yielded relatively high as compared with $\frac{15}{16}$ inch cottons, and when one best variety in each group is chosen the $1\frac{1}{16}$ and $1\frac{3}{16}$ inches cottons bred by this substation returned the highest yields and a much higher acre value than other staple lengths. Conditions in the Delta and the States farther east differed principally in soil fertility and soil moisture.

**241.** Cotton-Ginning Costs in North-Central Texas. By J. S. Hathcock. (*U.S. Dpt. Agr. Tech. Bull.*, No. 13, 1927. Abstr. from *Summ. of Curr. Lit.*, viii., **1**, 1928, E. 3.) An analytical study of the ginning industry in respect of plant and output, costs of power and labour, and profit obtained. The data given are for a year (1924-25), which was considerably better than average. Appendices on determination of cost of maintenance, capital investment of gin plants and Texas laws relating to ginning, together with miscellaneous tables, are given.

**242.** The Establishment of Standard Grades for American Cotton Linters. By G. S. Meloy. (*U.S. Dept. Agr. Misc. Pubn.*, No. 10, 1927.)

**243.** Merchandising Spot Cotton in the United States. By W. D. Espy. (Abstr. from *Int. Cot. Bull.*, vi., **21**, 1927, p. 73.) A clear account of the methods in use for selling cotton.

**244.** Labour Saving Appliances in the U.S.A. Cotton Mills. By Arno. S. Pearse. (Abstr. from *Int. Cot. Bull.*, vi., **21**, 1927, p. 153.) A well-illustrated description of the various labour-saving appliances in use in a mill at Nashua, N.H., chiefly in the transport of material from one department to another.

**245.** Cotton Textile Institute, U.S.A. (*Text. World*, 1927, **72**, 2293-2295. Abstr. from *Summ. Curr. Lit.*, vii., **22**, 1927, M. 30.) A report of the first annual meeting of the Cotton Textile Institute in New York. The meeting was attended by about 250 of the most representative cotton manufacturers of the country. The main activities to date have been the development of statistical information relating to production, stocks, orders, etc., work on cost accounting, and the investigation of new uses for cotton fabrics. The work of the Institute is organized on a group basis.

## *COTTON IN FOREIGN COUNTRIES.*

**246.** Brazil. *Cotton Planting.* (Abstr. from *Commercial Oldham*, vol. ii., No. 5, 1927, p. 10.) The distribution of seed by the Department of Agriculture during recent weeks shows that the present high prices have stimulated interest in the growing of cotton, and it is estimated that if climatic conditions are favourable, this seed—to a total of 380,995 kilos—will produce approximately 27,000 tons, which, at present prices, would be worth 1,000,000 contos. One-third part of this seed was produced by the cotton stations or private individuals working under the technical guidance of the Secretariat of Agriculture, and is for the production of such varieties as "Salisbury," "Express," "Delfos," "Texas Big Boll," and "Day's Special," all of these varieties having a staple of more than 28 mm. The remainder was seed produced by the São Paulo Produce Exchange and by private planters who had received licenses for the sale of seed, and whose plantations are under the inspection of the inspectors of the Cotton Service. The varieties included "Russell," "Novo Paulista," "Præcox," "Sunbeam," "Cleveland," and others. All this seed was disinfected at the Government stations.

**247.** *Cotton Congress.* (Abstr. from *Int. Cot. Bull.*, vi., **21**, 1927, p. 109.) A national cotton congress was held at Rio de Janeiro in August, the outcome of which are resolutions relating to the uniform grading of cotton throughout the whole of Brazil, the collection of statistics from ginning factories and presses, etc. The Government is requested to increase the experimental stations, to assist individual firms in their seed selection, to improve and extend seed disinfection, and to enforce the compulsory supervision of cotton-seed distribution and sales. It is also proposed that Government experts should examine, before the beginning of a crop, all machinery existing in ginning factories, machines not found to be in perfect working order to be condemned.

248. BRAZIL. (Abstr. from *Int. Cot. Bull.*, vi., 21, 1927, p. 131.) Cotton mills are suffering owing to lack of money in the interior to pay for orders or to place new ones. Both the São Paulo and Rio de Janeiro cotton spinners and manufacturers are requesting the Government to increase the import duties on cotton yarn and goods owing to the bad trade they have had during the last three years.

249. COLOMBIA. (Abstr. from *Int. Cot. Bull.*, vi., 21, 1927, p. 110.) The Government of Colombia has organized a special department to deal with immigration and colonization, which should be of great help in the introduction and expansion of cotton-growing.

250. CZECHO-SLOVAKIA. *Cotton Industry.* (Abstr. from *Int. Cot. Bull.*, vi., 21, 1927, p. 131.) Employment in the cotton industry during the last three months has been good. The home trade and the export trade are developing on quite normal lines. It is to be regretted, however, that prices realized for the sale of the cotton goods do not keep the same step with the raised cotton prices.

251. DRY LAND COTTON CULTURE IN FRENCH WEST AFRICA. (Trans. title.) By Persévérer. (*Acad. Sci. Colon. Ann.*, 2, 1925. Abstr. from *Exp. Sta. Rec.*, lvii., 7, 1927, p. 630.) This memoir describes the zones favourable to cotton production without irrigation, the importance of the industry, the species grown, cultural methods, improvement practices, and insect pests and diseases. Economic problems and producers' associations are also discussed.

252. We have received from the Association Cotonnière Coloniale a copy of Bulletin No. 81, containing interesting information relating to cotton production in the French Colonies.

253. THE RAISING AND MARKETING OF COTTON IN PERU. By P. Reinhart. (Abstr. from *Int. Cot. Bull.*, vi., 21, 1927, p. 112.) A clear and concise article which should be read by anyone interested in Peru.

254. PERU. *Cotton Crop.* (Abstr. from *Int. Cot. Bull.*, vi., 21, 1927, p. 111.) Sales of the new cotton crop are exceeding those for the same period last year, and the prospects for a large crop of high quality, with about 200,000 bales for export, are materializing.

255. MARKETING COTTON IN SOUTH AMERICA. By E. L. Tutt. (Abstr. from *Int. Cot. Bull.*, vi., 21, 1927, p. 117.) A good summary of the present position in regard to cotton.

256. TRANSACTIONS OF THE DAGHESTAN AGRICULTURAL PLANT-BREEDING STATION, DERBENT, CAUCASUS. We have recently received a copy of vol. i. of the above Transactions, describing the foundation and organization of the Station, and its branches.

257. THE 1927 COTTON CROP, ALEPPO DISTRICT. The Société Cotonnière de Mulhouse, which runs an experimental farm at Djeble in the State of the Alawites, made a trial with Lone Star cotton seed in this district. The arrangement was that the seed was sold to cultivators at the price of ordinary local seed, known

as "baladi" seed, and that the Company should have the right to buy the crop, also at the price of "baladi" cotton. The experiment, from the agricultural point of view, was a complete success, but unfortunately for the Company, the cultivators took advantage of this success to dishonour their obligations, and sold their crop in open market at a higher price than "baladi" cotton. The French authorities were persuaded to intervene with a view to recovering the crop for the Company, but their efforts were only partially successful. It seems doubtful whether, after this unfortunate experience, the Société Cotonnière will be inclined to repeat the experiment next season, unless some stricter form of guarantee can be devised.

## *CULTIVATION AND MACHINERY : IRRIGATION, ETC.*

258. The Arrangement of Field Experiments. By R. A. Fisher. (*Jour. Min. Agr.*, xxxiii., 6. Abstr. from *Agr. J. of India*, vol. xxii., Pt. 3, 1927, p. 201.) An interesting article that should be read by all who have to conduct field experiments. The subject is dealt with under the following headings: The present position; When is a result significant? Measurement of accuracy by replication; Errors wrongly estimated; The Latin Square; Complex experimentation.

259. Cotton Seedling. Salt Intake. By A. R. C. Haas. (*Bot. Gaz.*, 84, 1927. Abstr. from *Summ. Curr. Lit.*, viii., 1, 1928, A. 1.) Results of experiments are tabulated showing the absorption and growth of Egyptian and Upland types of cotton seedlings from solutions containing chloride or sulphate. In the sulphate series the Egyptian type absorbed more of the sulphate than the Upland type. In the chloride series the Egyptian type generally absorbed more than the Upland type, but results were not so consistent at low concentrations of chloride. The results suggest that the absorption of chloride and sulphate by the roots of plants may not bear the same relationship to one another in the different types of cotton seedlings as do the chloride and sulphate content of the leaf tissue fluids, and, therefore, the absorption of ions as a basis for distinctions between different types of cotton seedlings requires further study.

260. Sudan. Sulphur as a Fertilizer. (Abstr. from the *Rpt. of the Govt. Chemist*, 1926. *Wellcome Trop. Res. Laboratories, Khartoum*, p. 24.) A field trial has been carried out in which five small plots ($\frac{1}{24}$ acre) were treated with sulphur at the rate of 1 ton per acre: five similar plots were used as controls. Cotton was sown on June 6, 1925, and the results were as follows:

| | *Blank Plots.* | *Sulphur Plots.* |
|---|---|---|
| pH before the trial .. .. .. .. .. | 8·78 | 8·60 |
| pH after the trial .. .. .. .. .. | 8·84 | 8·28 |
| Soluble salts after trial (in first foot samples) .. | 0·089 | 0·361 |
| Yield lb. of seed cotton per acre .. .. .. | 869 | 936 |

The increase of yield (8 per cent.) is not great, but there is a very satisfactory reduction in alkalinity in the treated plots.

261. Cotton in Egypt. Soil Temperatures. By E. McKenzie Taylor. (*J. Agr. Sci.*, 1927, 17, pp. 489-501. Abstr. from *Summ. Curr. Lit.*, vii., 24, 1927, E. 71.) During the periods of germination and increase in height of the cotton plant, the soil temperatures are rising and the amplitude of the temperature wave is at its maximum. The maximum soil temperatures decline while the minimum soil temperatures remain constant, thus resulting in a gradual decrease in the amplitude of the daily temperature wave during the branching and flowering periods. Throughout the soil zone occupied by the roots of the plant, the

temperature is the same, the amplitude of the daily temperature wave small, and the temperature is constant during the boll development and maturation periods. The main effect of irrigation on soil temperatures is to reduce the amplitude of the daily temperature wave, no sudden change of temperature in the root zone taking place. From a consideration of the range of air temperature in other cotton-producing countries, it seems probable that the characteristics of the soil temperatures during the boll development and maturation periods are the same for all countries.

262. THE EFFECT OF ABSORPTION BY PLANTS ON THE CONCENTRATION OF THE SOIL SOLUTION. By C. S. Scofield. (Abstr. from *Jour. Agr. Res.*, 35, No. 8, 1927, p. 745.) The results of the experiments appear to warrant the conclusion that crop plants do not absorb water and dissolved substances from the soil solution in the same proportions that these constituents occur together in that solution. With the range of solution concentrations used, and under the conditions of the experiments here described, the residual solutions were definitely more concentrated than the original solutions. The quantity of water absorbed by the plants during the twenty-four days of the experiments was approximately equivalent to the original volume of the culture solutions, yet at the end of that period the residual solutions contained 78 to 91 per cent. of the salts originally present.

It is true that the experiments were conducted in a laboratory and not in the field, and that plants were grown in culture solutions and not in soil; yet it is believed that the results are fairly applicable to field conditions. Furthermore, there is abundant field evidence to show that when saline irrigation water is used so sparingly that the root zone is seldom or never leached, it is merely a question of time until the soil solution of the root zone becomes so concentrated that crop plants cannot absorb from it the water required to make normal growth.

Irrigators are sometimes inclined to believe that if it is necessary to use salty irrigation water it should be used sparingly so as to avoid carrying to the field more salt than is necessary. In the light of such evidence as is available, this method of procedure is not to be recommended. The only known way to remove soluble salt from the soil of the root zone is by leaching. Consequently, if saline water must be used for irrigation, it should be applied in sufficient quantities not only to supply crop needs and to meet evaporation losses, but also to leach the root zone and thus carry away the salts that are left by the water that is evaporated from the soil and absorbed by the plants. In other words, the more salt there is in irrigation water the more water should be used in irrigating. Most of the ordinary crop plants are not able to absorb the water needed for normal growth from a soil solution containing more than ·15 to ·2 per cent. of salts. This means that if the irrigation water contains as much as 1,500 to 2,000 parts per million of salt, a sufficient quantity of it should be used so that at least 10 per cent. of the quantity applied to the surface of the soil will percolate down through the root zone.

It will be readily understood that in order to leach the root zone the conditions of the subsoil below it must be such that the percolating water may pass away through either natural or artificial channels. Soils that are underlain by strata of impermeable material such as hardpan, rock, or tight clay, or below which the subsoil is already saturated with stagnant water, cannot be leached, and consequently are almost certain to become unproductive if irrigated with saline water. This fact makes it essential to take into account the subsoil conditions of irrigable land if the plans for its utilization contemplate its long-continued productivity.

It is coming to be generally recognized that irrigated lands need to have an assured and effective system of drainage, either natural or artificial. Unfortunately, it is not yet so generally recognized that the real function of a drainage system is quite as much to remove surplus salt as to remove surplus water. It is now regarded as normal and routine engineering practice to measure the quantity of water that is delivered to the land for irrigation, or that is discharged from irrigated land as drainage, but there are as yet relatively few irrigation engineers who appreciate the need of, or who are equipped to make, determinations of the salt content of irrigation water or of the drainage. With respect to any area of irrigated land, there should be available, not only to the farmer, but also to the investor, accurate information as to the quantity and character of the salts that are being carried to the land by the irrigation water, and also as to the ultimate disposition that is being made of this salt. If the conditions of the subsoil or the methods of irrigation are such that the salt is largely remaining in the root zone, then it is inevitable that the land must ultimately become unproductive. On the other hand, if it can be shown that drainage conditions are such that the salts of high solubility brought in by the irrigation water are being carried away in the drainage, there can be reasonable assurance that the irrigated lands should long continue to be productive.

**263.** Cotton Plant. Manuring. By J. J. Skinner and W. F. Pate. (*Bot. Abstr.*, 1926, **15**, p. 882, from *J. Amer. Soc. Agron.*, 1925, **17**, pp. 550-556. Abstr. from *Summ. Curr. Lit.*, vii., **23**, 1927, E. 70.) Wanamaker's Cleveland cotton and Mexican Big Boll were grown on fine sandy loam. Phosphate had very little effect on yield, but affected the maturing of the cotton. Nitrogen produced a vigorous plant capable of producing an abundance of fruit. Potash is a prime factor in the metabolism of the plant in rust prevention, boll formation, and maturation. Potash was very striking in its effect on cotton in this soil, and its influence is more pronounced than on most soils of the cotton belt.

**264.** Snapped and Sledded Cotton. (*Cotton*, 1927, **91**, p. 1227. Abstr. from *Summ. Curr. Lit.*. vii., **23**, 1927, F. 34.) It is suggested that snapped and sledded cotton should be double-carded. Additional expenditure for machinery would soon be offset by the price advantage of the snapped or sledded cotton, and the expenditure for the second process is a small factor compared with the advantage gained.

**265.** Cotton Harvesting Machinery. Description. (International Harvester Co.) (*Text. World*, **72**, 1927, p. 2193. Abstr. from *Summ. Curr. Lit.*, vii., **22**, 1927, E. 68.) Descriptions are given of the following new machinery: (1) A mechanical picker of the spindle type which is moved over the fields by means of a tractor; (2) a stripper which gathers both ripe cotton and unopened bolls in one operation; (3) a cleaner used in connection with the stripper, and comprising a self-contained, power-operated, stationary machine to which the bolls and stripped cotton are brought.

**266.** Roller Gin. By L. Mellersh-Jackson. (Abstr. from *J. of Text. Inst.*, xx., **1**, 1928, A. 10.) In a double roller gin, the ginning rollers are carried by arms moving about fixed pivots, and are held up to the fixed knives by weighted bell-crank levers, having adjustable screws bearing against lugs on the arms. The main shaft drives through gears a gear on one of the pivots. This meshes with an equal gear on the other pivot, and these gears drive the rollers through gears. Adjustment of the rollers due to wear, etc., leaves the gear trains in proper mesh. The whole of the gearing is encased by a box, the lower part of which is used as an oil bath. The shaft carrying the knives is oscillated by an eccentric on the main shaft.

## *DISEASES, PESTS, AND INJURIES, AND THEIR TREATMENT.*

**267.** On the Effect of Mechanical Control on the Progress of Introduced Parasites of Insect Pests. By W. R. Thompson. (*Bull. Ent. Res.* xviii., **1**, 1927. Abstr. in *Rev. App. Ent.*, xvi., **1**, 1928, p. 45.)

268. A HIBERNATING CAGE FOR INSECTS. By H. Prell. (*Jour. of Econ. Ent.*, vol. xx., No. 6, 1927, p. 830.)

269. THE USE OF HYDROCYANIC ACID GAS FOR THE FUMIGATION OF AMERICAN COTTON ON IMPORT INTO INDIA. By A. J. Turner and D. L. Sen. (Abstr. from *Agr. J. of India*, vol. xxii., Pt. 3, 1927, p. 172.) Experiments were carried out to determine first what concentration of HCN and what duration of exposure are necessary in order to exterminate boll weevils, and, secondly, whether the cotton, or its jute covering, may absorb and subsequently desorb HCN, and if so, to what extent. In India the experiments were confined to a resistant weevil —the grain weevil, *Sitophilus oryzæ*—but it was subsequently arranged with the American authorities to repeat the work, using the Mexican boll weevil itself.

The conclusions drawn from the cotton absorption experiments were: (1) That cotton does absorb HCN, whether the cotton be loose or baled, dry or damp; (2) that damp cotton is rather more absorbent than dry cotton, although the difference in absorption even for extremes of humidity is not more than 50 per cent. of the total absorption; (3) that within the limits of temperature 86° to 104° F. the actual temperature has very little influence either on the rate or on the degree of absorption of HCN by cotton; (4) that absorbed HCN is desorbed fairly rapidly and completely, and that there is no evidence of the occurrence of any irreversible chemical combination; (5) that with water present in the cyanide-acid reaction the weight of sodium cyanide required for satisfactory fumigation is about 0·05 per cent. of the weight of the cotton, but that where leakage has to be contended with—as when using barges on a practical scale—the weight of sodium cyanide required is about 0·07 per cent. of the weight of the cotton, or one pound weight of sodium for three bales of cotton. Subsequent experience on the practical scale has shown, however, that one pound weight of sodium cyanide is sufficient for the satisfactory fumigation of about five bales of cotton, where good barges are used and the bales are both dry and also compressed to a high density; (6) that fumigation with HCN can be satisfactorily carried out on a large scale in barges.

The conclusions drawn from the jute absorption experiments are: (1) That jute has about twice the absorptive power of cotton, and, moreover, absorbs the HCN at a more rapid rate; (2) that the absorptive power of jute is only to a small extent dependent on its moisture content, being, however, slightly greater for damp jute than for dry; (3) that the absorptive power of jute remains practically unchanged through the temperature range 86° to 104° F.

270. FRENCH EQUATORIAL AFRICA: COTTON PESTS AND DISEASES NOTED RECENTLY IN THE CHARI BASIN. (Abstr. from *Int. Rev. of the Sci. and Pract. of Agr.*, Rome, xviii., 9, 1927, p. T-567.) The pests and diseases mentioned are *Sylepta derogata*, Fab.; *Nezara viridula*, F.; *Anoplocnemis curvipes*, Fab.; *Oxycarenus hyalinipennis*, Costa; *Dysdercus superstitiosus*, Fab.; *Aphis gossypii*, Glov.; *Eriophyes gossypii*, Bks.; and the Mosaic disease.

271. COTTON PESTS IN GUADELOUPE. (Abstr. from *Int. Rev. of the Sci. and Pract. of Agr.*, Rome, xviii., 9, 1927, p. T-503.) *Dysdercus delauneyi* is generally the worst enemy of cotton. Angular Leaf Spot and Rust (*Kuehneola gossypii*) are often found, and cause considerable damage.

272. NIGERIAN INSECT PESTS OF COTTON. By F. D. Golding and Owen B. Lean. (Abstr. from *Proc. of the First West Afr. Agr. Conference*, held at Ibadan, Nigeria, March, 1927, p. 129, a copy of which has recently been received.) An outline of the entomological work that has been done on cotton pests in recent years by members of the Nigerian Agricultural Department. Results are summarized under the following heads: Bud Shedding, Boll Shedding, Harvested Bolls, Cotton Stainers, Bollworms, Close Season Measures, Minor Cotton Pests.

273. COTTON-GROWING IN QUEENSLAND, Pt. 2. PESTS OF COTTON IN QUEENSLAND. By E. Ballard. (Abstr. from *Queens. Agr. Jour.*, xxviii., 6, 1927, p. 589.) Deals with (1) the Major pests of cotton: Corn Ear Worm, Peach Grub, Pink Bollworm: (2) the Minor pests: Cutworms, Rough Bollworm, Cotton Stainers, Harlequin Bug, Cotton Seed Bug, False Stainer, Aphids, Jassid or Leaf Hoppers. The article, which is well illustrated, describes the habits of the insects, and methods of treatment.

274. SOUTHERN RHODESIA: COTTON PESTS. By R. W. Jack. (*Rpt. Secy. Dpt. Agr.*, 1926. Salisbury, 1927. Abstr. from *Rev. App. Ent.*, xv., 12, 1927, p. 638.) Pests of cotton recorded during 1926 in Southern Rhodesia included *Heliothis obsoleta*, F. (American bollworm), *Earias* sp. (Spiny bollworm), *Diparopsis castanea*, Hmps. (Red bollworm), *Dysdercus* sp., *Oxycarenus* sp., *Cosmophila flava*, F. (*Anomis fimbriago*, auct.), and general feeders, such as cutworms and surface beetles (Tenebrionids).

Observations were commenced during the year to discover whether lint-staining and premature reddening of foliage, which were the chief troubles connected with the cotton crop during 1925-26, were wholly due to the influence of *Dysdercus* and the Jassid, *Empoasca* (*Chlorita*) *facialis*, Jac., respectively, as had been suggested. *Bacterium malvacearum*, and fungi of the genera *Nematospora*, *Phytophthora*, *Fusarium*, and (?) *Alternaria* were obtained from stained lint.

275. SUDAN: COTTON PESTS. (Extr. from *Rpt. on the Finances, Administration and Condition of the Sudan in* 1926, p. 74. (Pubd. 1927. Cmd. 2991.) "The Government Entomologist, Mr. H. H. King, and his staff have had in hand various important investigations, among which may be mentioned investigations into Cotton Thrips, Termites, and Locusts in the Gezira, Sudan Bollworm, and Pink Bollworm at Gendettu, and Red Stainer Bugs in Fung and Nuba Mountains Provinces."

276. UGANDA: COTTON PESTS. (Abstr. from the *Ann. Rpt. of the Dpt. of Agr.*, 1926.) *Cotton Stainers.*—From a report of the Assistant Entomologist we quote the following: "In view of statements made in various parts of Africa that guinea-fowl are beneficial in controlling stainers, it may be mentioned that examinations of crop contents of these birds show that their chief food is grass seeds, sweet potato, and various native-grown grains or pulses; they do, however, feed on all insects occurring in the plots where they are feeding. When they are feeding in cotton plots where stainers occur, all instars of these bugs may be found in their crops, and these birds may, therefore, be recognized as beneficial to the cotton at the time when stainers are feeding on the plants."

277. UGANDA: COTTON PESTS. (Abstr. from the *Ann. Rpt. of the Dpt. of Agr.*, 1926.) *Platyedra erebodoxa*, Meyr.—Mr. Hancock, the Assistant Entomologist, reports as follows regarding this insect: "In view of the fact that the 'pink bollworm' has been recorded as a pest of cotton on the coastal area in Kenya, it may be well to mention that the Uganda insect mentioned in my report for 1925, under the name of *Platyedra gossypiella*, Saund., and which feeds only on wild hibiscus, has, on the receipt of further material by Mr. Meyrick, been described by him as a distinct species under the name of *Platyedra erebodoxa*, Meyr. In view of the resemblance between this insect and cotton-feeding *P. gossypiella* of Kenya, Tanganyika, and the Sudan, it may be well to mention that the larva of this species appears to be indistinguishable from the larva of the cotton-feeding *Platyedra scutigera*, Holdaway, of Australia. It may thus be separated from *P. gossypiella* by the characters of the prolegs and of the prothoracic shield, as well as by the arrangement of the colour pattern. It is possible that the parasites of this insect might feed on *P. gossypiella*, and therefore it may be of interest

to record three parasites at present unidentified, but apparently belonging to the genera *Microbracon*, *Chelonus*, and *Apanteles*. The last is, unfortunately, heavily parasitized, but parasites of the *Microbracon* are rare and the *Chelonus* appears to be free from attack. There are still no records of true pink bollworm, *P. gossypiella*, in Uganda."

278. LAS PLAGAS DEL ALGODONERO (Pests of the Cotton Plant). (*Mexico: Soc. Agric. y Fomento, Bol. mens. Defensa agric.*, i., 2, 1927. Abstr. in *Rev. App. Ent.*, xv., 11, 1927, p. 609.)

279. We have received from the Agricultural Res. Inst., Pusa, a copy of *List of Publications on Indian Entomology*, 1926. (Obtainable from the Govt. of India Central Pubns. Branch, Imperial Secretariat Bldg., 3, Government Place, West, Calcutta. Price As. 10, or 1s.)

280. SOME NEW INDIAN MIRIDÆ (CAPSIDÆ). By E. Ballard. (*Mems. of the Dpt. of Agr. in India*, Pusa, vol. x., No. 4, 1927. Pubd. by Govt. of India Central Pubns. Branch, 3, Government Place, West, Calcutta. Price As. 6, or 8d.)

281. REPORT OF THE DEPARTMENT OF ENTOMOLOGY. By W. E. Hinds and H. Spencer. (*Louisiana Stas. Rpt.*, 1926. Abstr. from *Exp. Sta. Rec.*, lvii., 6, 1927, p. 554.) In reporting upon boll weevil control work, it is stated that of 13,295 weevils placed in a number of hibernation cages at the station in the fall of 1925, 5·87 per cent. emerged, the crest of emergence occurring after the middle of May.

282. NOTES ON THE BIOLOGY AND HABITS OF THE PERUVIAN COTTON SQUARE WEEVIL (*Anthonomus vestitus*, Bohm.). By W. E. Hinds. (*Ann. Ent. Soc. Amer.*, xx., 2, 1927. Abstr. from *Rev. App. Ent.*, xv., 11, 1927, p. 597.) *Anthonomus vestitus*, Bohm. (Peruvian cotton square weevil) has a much lower reproductive capacity than *A. grandis*, Bohm., with which its habits are compared, and it is believed to be a very much less serious pest than the latter. The observations described were made in the field and the laboratory in the cotton-growing valleys of Peru in 1926. In observations on a limited number of individuals at an average temperature of 79° F., the egg stage lasted 66 to 72 hours, the larval stage 8 to 9 days, and the pupal 3 to 6 days, followed by a period of 2 to 3 days before the adult emerged, so that the total life-cycle from oviposition to the emergence of the adult was 15 to 20 days.

In the Canete Valley *A. vestitus* was found to be common in practically all fields, being active from January, the beginning of the squaring season, to the end of the growing season, and frequently causing considerable damage. The bolls are seldom attacked for feeding or oviposition, a great preference being shown for young squares, those with a diameter of about ¼ inch being usually attacked. The reason for this appears to be that the snout of the weevil is too short to penetrate the floral envelope and enable it to feed on the pollen sacs in squares with a diameter of more than $\frac{7}{16}$ inch. *A. vestitus* shows the same dependence on pollen as food necessary for normal egg production as does *A. grandis*. The preoviposition period of feeding of the adult may vary from 24 hours, where the female has access to a cut-open square, to 6 days, where there is difficulty in securing pollen. The eggs are placed almost invariably in the upper part of the constricted basal portion of the square. The larvæ gradually work their way into the pollen sac, where most of the later feeding occurs. The infested squares fall to the ground after 5 to 6 days, and most of the larval development occurs after the square has fallen.

283. CUTWORM BAIT POISONS. (*Quar. Bull. Miss. Pl. Bd.*, vii., 2, 1927. Abstr. from *Rev. App. Ent.*, xvi., 1, 1928, p. 19.) The author made several small experiments to test the relative value of sodium fluosilicate and Paris green in the

bait for cutworms, and found that, contrary to the experience of other workers, Paris green was in every case the more toxic of the two materials.

284. Quantitative Methods of Collecting and Rearing Soil Cutworms. By K. M. King and N. J. Atkinson. (Abstr. from *Jour. Econ. Ent.*, vol. xx., No. 6, 1927, p. 821.) In this paper are described in considerable detail the methods of collecting and rearing soil-infesting cutworms which several years' experience has shown to be the most suitable and efficient, under Saskatchewan conditions, for securing accurate estimates of the relative (and to some extent the actual) abundance of the cutworm species involved, and the abundance and effectiveness of their various insect parasites and diseases. An attempt is made to distinguish between those methods which are essential under nearly all circumstances, and those which, though non-essential, should be employed when conditions permit. A few instances are cited illustrating the working out of these methods in actual practice.

Three general conclusions are drawn: (1) Each cutworm must be kept isolated from the moment of collection, and be reared with such precautions as will minimize the subsequent effects of the changes or conditions, or the possibilities of cross-infection. The employment of this technique, more than any other point in the procedure, conditions the entire results. (2) The methods of collecting must be so systematized as to make each collection truly representative of its immediate location. (3) More valuable returns are secured, for the efforts expended, by making several successive or otherwise comparatively small collections rather than a few large ones.

285. Some Effects of Alternating Temperatures on the Growth and Metabolism of Cutworm Larvæ. By W. C. Cook. (Abstr. from *Jour. Econ. Ent.*, vol. xx., No. 6, 1927, p. 769.) The first part of this paper presents the results of experiments in which larvæ of *Porosagrotis orthogonia*, Morr., were reared with daily alternations of high and low temperature. It was found that growth was accelerated by these alternations, the highest acceleration being for an eight-hour exposure to high temperatures.

In the second part of the paper, experiments are discussed in which the metabolism of larvæ of *Chorizagrotis auxiliaris*, Grt., was measured after varying exposures to high temperatures. Here also it was found that metabolism, as measured by carbon dioxide output, also showed a maximum for an eight-hour exposure.

Both sets of experiments are discussed in relation to current chemical theories, and a time-temperature-rate surface is developed which shows the general relationship.

286. Cutworm Control on Overflowed Land. By C. Lyle. (*Qtrly. Bull. State Pl. Bd. Mississippi*, vii., 1, 1927. Abstr. from *Rev. App. Ent.*, xv., 12, 1927, p. 630.) From past experience, it is thought most probable that the flooded areas of Mississippi will suffer severe damage from cutworms, the adults of which seem to be attracted for oviposition to rank grass and damp soil, while their natural enemies will doubtless have been drowned. The most destructive species generally found on flooded lands is *Laphygma frugiperda*, S. and A., which passes the winter in the extreme southern part of the cotton belt, the moths flying northward in the spring, and each successive generation extending further north. As soon as adults and larvæ are observed in southern Mississippi, the campaign against them will begin, and they may be expected in the Delta region four or five weeks later. Light traps should be used to catch the adults at night. Grasses, which are the natural food-plants, should be examined daily for eggs, and as soon as any are seen, watch should be kept for the larvæ and poison bait promptly applied. For this 50 lb. wheat bran or shorts should be thoroughly mixed with

1 lb. Paris green or sodium fluosilicate, then gradually moistened with water and again mixed; on heavily infested areas from 15 to 20 lb. dry weight should be applied to the acre. On patches of grass, spraying with 2 lb. Paris green to 50 U.S. gallons water may be substituted for poison bait.

287. CALCIUM ARSENATE AS A CAUSE OF APHIS INFESTATION. By J. W. Folsom. (Abstr. from *Jour. Econ. Ent.*, vol. xx., No. 6, 1927, p. 840.) The conclusions arrived at by the author are as follows: Excessive applications of calcium arsenate are often followed by heavy infestations of the cotton aphis. The initial infestations are due to the positive phototropic reaction of winged females to white substances, such as calcium arsenate, calcium carbonate, starch or flour. A heavy infestation is built up, not by the destruction of predators by calcium arsenate, but by the killing of hymenopterous parasites when they emerge in the presence of the arsenical. They are killed also, though more slowly, by calcium hydroxide, calcium carbonate, and corn starch.

288. THE VARIABILITY OF *Aphis gossypii*. By C. H. Batchelder. (*Ann. Ent. Soc. Amer.*, xx., 2, 1927. Abstr. from *Rev. App. Ent.*, xv., 11, 1927, p. 597.) As there has been considerable confusion in literature concerning the identity of *Aphis gossypii*, Glov., the possible range of variation is here dealt with, as studied from individuals bred from various food-plants under controlled conditions.

289. ENTOMOLOGICAL INVESTIGATIONS AT THE OKLAHOMA STATION. By C. E. Sanborn *et al.* (*Oklahoma Sta. Bien. Rpt.*, 1925-26. Abstr. from *Exp. Sta. Rec.*, lvii., 6, 1927, p. 555.) The Cotton Flea Hopper caused its first injury in the State during the summer of 1926. Many fields, especially the most productive areas along river valleys, were damaged to such an extent as to produce an exceedingly large vegetative growth with little or no fruit.

290. O PODADOR, CHALCODERMUS BONDARI, MARSH. NOVA PRAGA DO ALGODOEIRO NA BAHIA (The Pruner, *C. bondari*, Mshl. A New Pest of Cotton in Bahia). By G. Bondar. (*Chacaras e Quintaes*, xxxvi., 2, S. Paulo, 1927. Abstr. from *Rev. App. Ent.*, xv., 11, 1927, p. 610.) *Chalcodermus bondari*, Mshl., was first noticed in 1925 in the cotton fields of Bahia. The adult weevil bores into the twigs to oviposit, and at these points the tips of the twigs bend over or break off. The resultant withering must be unfavourable to the growth of the plant, while many flowers and bolls are lost. The egg hatches in 2 to 3 days, and the larva is full-grown in 7 to 8 days, after which it enters the ground, where it passes about 10 days before pupating. The adult emerges about 20 days later. In the laboratory the complete life-cycle required a little under 2 months. The adult hides in the ground by day. *C. bondari* has evidently passed to cotton from some unknown indigenous plant.

291. COTTON INSECT PEST IN ARIZONA AND CALIFORNIA. DESCRIPTION. By E. A. McGregor. (*Tech. Bull. No. 4, U.S. Dpt. Agr.* Abstr. from *Summ. of Curr. Lit.*, viii., 1, 1928, E. 2.) The tarnished bug, *Lygus elisus*, Van Dazee, is perhaps the most serious pest of cotton on the Pacific coast. Injury is caused by feeding punctures made in the squares, blooms, and bolls, which are then soon shed. It is supposed that either a toxic material or an organism is introduced into the plant tissue. The pest produces characteristic yellow daubs. Infested alfalfa growing in the neighbourhood is a common source of acute attacks on cotton. Finely divided sulphur dust has been found effective against the tarnished bug.

292. LOCUSTS AND GRASSHOPPERS. By B. P. Uvarov. (In Russian.) (*Bibliot. Khlopkovogo Dela.*, 8, Moscow, 1927. Abstr. from *Rev. App. Ent.*, xv., 11, 1927, p. 618.) In the concluding chapter the opinion is expressed that from the technical point of view the control of locusts does not present any difficulties, the poison bait method being considered the best of all under all conditions, but

the effectiveness of control measures depends entirely on organization. Further research on locusts and grasshoppers is, however, urgently needed, since the total information on the most vital problems of bionomics is exceedingly small, while a thorough understanding of the physiology and ecology of the insects is absolutely essential for developing schemes for preventing outbreaks. Detailed research on the anatomy, physiology, and embryology of *Acrididæ*, even if carried out without any practical end in view, would be immensely important to economic entomology.

293. THE MIGRATORY LOCUST AND ITS CONTROL. By B. A. Pukhov. (Russian.) (*Bibl. Agron.*, Moscow, 1927. Abstr. in *Rev. App. Ent.*, xv., 12, 1927, p. 655.)

294. THE LOCUST ATTACK OF 1926-27 IN SIND, KATHIAWAR, AND GUJARAT. By H. H. Mann and W. Burns. (*Agr. J. of India*, xxii., Pt. v., 1927, p. 325.)

295. SYRIA. EXPERIMENTS ON LOCUST DESTRUCTION. (Abstr. from *Int. Rev. of the Sci. and Pract. of Agr.*, Rome, xviii., 9, 1927, p. T-506.) Pyrethrum soap solution, 2 to 4 per cent., was very successfully used against locusts, by spraying it upon them at about 6 a.m., when they were still torpid. Arsénison was even more successful.

296. LE PROBLÈME ACRIDIEN. By P. Vayssière. (*Matér. Étude Calamités*, iv., 14, Geneva, 1927. Abstr. from *Rev. App. Ent.*, xvi., 1, 1928, p. 12.) A review of the locust and grasshopper situation in various countries during 1926 and the early part of 1927, based on official reports. A review of the progress in research on *Acrididæ* is also given.

297. QUANTITATIVE STUDIES ON THE EFFICIENCY OF FUNGICIDES. By J. MacInnes. (*Phytopathology*, 55, 1925, No. 4. Abstr. from *Exp. Sta. Rec.*, 57, 9, 1927, p. 839.) Results obtained by use of copper sulphate, mercuric chloride, and formaldehyde indicate rather definitely that, in connection with *Aspergillus niger* at least, conductivity may be used as a measure of the relative effectiveness of fungicides.

298. FUNGOID PESTS OF COTTON. By T. Laycock and G. H. Jones. (Abstr. from the *Proc. of the First West African Agricultural Conference*, held at Ibadan, Nigeria, in March, 1927.) Deals with the following diseases of cotton: Internal Boll Rot, Anthracnose Boll Rot, and Fusarium Boll Rot.

[*Cf.* also Abstracts 365 of vol. iii. and 420 of vol. iv.]

299. ROOT DISEASES OF ECONOMIC CROPS. A REPLY TO DR. W. SMALL. By C. H. Gadd. (*Trop. Agriculturist*, lxviii., 6, 1927. Abstr. from *Rev. App. Mycol.*, vi., 12, 1927, p. 742.) In this paper the author subjects to severe criticism the hypothesis propounded by Small that root disease of economic crops in Ceylon, and probably also elsewhere, is due primarily to the parasitic activity of *Rhizoctonia bataticola*. He considers it would be most inadvisable for growers to discontinue the vigorous prosecution of the measures now in vogue for the control of root disease of plants.

300. RHIZOCTONIA BATATICOLA AND ROOT DISEASE. A REPLY TO DR. C. H. GADD'S CRITICISM OF MY VIEWS. By W. Small. (*Trop. Agriculturist*, lxviii., 6, 1927. Abstr. from *Rev. App. Mycol.*, vi., 12, 1927, p. 742.) In replying to Dr. Gadd's criticism of his views, the author states that he remains unconvinced by his opponent's reasonings and deductions, and sees no good reason yet to depart from his position in regard to the primary part played by *Rhizoctonia bataticola* in the causation of root disease of economic crops in Ceylon.

[*Cf.* Abstr. 116.]

301. THE FUSARIUM DISEASE OF COTTON WILT, AND ITS CONTROL. By T. Fahmy. (*Int. Bull. Plant. Protect.*, i., **5**, 1927. Abstr. from *Rev. App. Mycol.*, vi., **12**, 1927, p. 725.) A morphological and physiological study of the Fusarium responsible for the serious wilt disease of Sakel cotton in the Delta region of Egypt is stated to have shown it to differ from *F. vasinfectum*, and the author is accordingly referring to it as *F. vasinfectum*, var. *ægyptiacum*. On dilute Richards' solution the parasite produced a staling substance capable of causing wilt in healthy cotton seedlings. The parasite was isolated from layers of soil at a depth of 1 metre below the surface. A constant symptom of the disease is the discoloration, sometimes extending upwards into the stem, of the central cylinder of the root, while leaf mottling, death of the growing point, and stunting may or may not be present.

302. TOXINS EXCRETED BY THE FUSARIUM CAUSING WILT DISEASE OF COTTON, AND THEIR INFLUENCE ON THE HOST PLANTS. By G. S. Kulkarni and B. B. Mundkur. (*Indian Sci. Cong. Proc.* [*Calcutta*], **12**, 1925. Abstr. from *Exp. Sta. Rec.*, lvii., **6**, 1927, p. 543.) Cotton plants of a susceptible strain, placed in a filtrate of a solution in which the Fusarium causing cotton wilt disease had grown for a time, wilted, showing symptoms identical with those usually seen in the fields. The time required to wilt the plants varied with the age of the solution. The wilting apparently was not caused by the alkalinity, and while a lactate was found in the filtrate, this was shown not to cause the wilting. The filtrate contained no oxalate. Even resistant types of cotton wilted when placed in the filtrates. The conclusion is reached that the death of cotton plants is due to the toxin or toxins excreted by the fungus, and that these toxins are thermostable and not of an enzymic nature.

303. PARASITISM OF FUSARIUM WHICH CAUSES THE WILT DISEASE OF COTTON IN THE BOMBAY PRESIDENCY. By B. B. Mundkur and G. S. Kulkarni. (*Indian Sci. Cong. Proc.* [*Calcutta*], **12**, 1925. Abstr. from *Exp. Sta. Rec.*, 57, **6**, 1927, p. 543.) A review is given of early work on cotton wilt disease done in India, with a brief account of the literature on the rôle played by aluminum salts in plant life. The conclusion reached by previous workers that aluminum salts become available only in acid soils, is accepted, and it has been shown that the cotton soils are not toxic, in the sense that they are not acid, the alkalinity rendering the aluminum salts inactive. The conclusion is that the cotton wilt disease is due to a Fusarium, and that the microchemical tests which showed an accumulation of iron and aluminum salts are not reliable.

304. FACTORS INFLUENCING THE SEVERITY OF THE "CRAZY-TOP" (ACROMANIA) DISORDER OF COTTON. By C. J. King and H. F. Loomis. (*U.S. Dpt. Agr. Bull.*, 1484, 1927. Abstr. from *Exp. Sta. Rec.*, 57, **7**, 1927, p. 643.) Deals with a growth abnormality of cotton first observed in the Salt River Valley, Arizona, in 1918, which has since become economically important locally, and may soon develop very serious proportions.

Analogies or contrasts are indicated as regards certain diseases, and some conditions related to this abnormality are pointed out. Apparent soil and water relations are discussed. Hardness and dryness of soil may be factors, and root limitation and other abnormalities show some degree of positive correlation. The general tendency to shallow rooting in fields where crazy-top is prevalent is contrasted with the deep-rooting behaviour of plants in alluvial soils where acromania has never appeared. Apparently, increasing the water supply alleviates the conditions inducing the disorder. The causal agent, if an organism, bears the relation of a weak virus or parasite having little or no effect on the plants under favourable growing conditions. In cases shown crazy-top was absent or slightly prevalent in areas that had been cropped to alfalfa the year before, but more prevalent in areas continuously cropped to cotton for some years. A regular rotation system with alfalfa is a corrective method for obtaining better penetration and storage of water, which may also be improved by attention to direction of water flow and by conservation devices.

## *BREEDING, GENERAL BOTANY, ETC.*

305. Two Rare Types of Abnormality in Cotton Seeds. By S. G. Lehman. (*Jour. Elisha Mitchell Sci. Soc.*, 41, 925, Nos. 1-2. Abstr. from *Exp. Sta. Rec.*, 57, 6, 1927, p. 518.) "In any event the embryological situation herein described represents a rare case of polyembryony in the cotton plant."

306. New Species of Cotton Plants from Sonora and Sinaloa, Mexico. By O. F. Cook and J. W. Hubbard. (*Jour. Wash. Acad. Sci.*, 16, No. 12, 1926. Abstr. from *Exp. Sta. Rec.*, 57, 8, 1927, p. 729.) Technical descriptions and a determinative key are given for the cotton species noted earlier.

[*Cf.* Abstr. 124.]

307. A Cross between Indian and American Cottons. By B. B. Desai. (Abstr. from *Agr. J. of India*, vol. xxii., Pt. 5, 1927, p. 351.) It is well known that crosses between American and Indian cottons are extremely difficult to obtain. While the cottons of the Old World cross with one another quite easily, and those of America are equally fertile among themselves, it has been usually considered that it is practically impossible, by any known method, to secure a cross between them. The opportunity to make an attempt in this direction came to the writer when working at Dharwar. Here a pure strain of Kumpta cotton (*Gossypium herbaceum*) known as Dharwar No. 1, and of Dharwar-American (Upland) cotton, known as Gadag No. 1, isolated by Kottur, are maintained. Using these types as materials, and employing Gadag No. 1 (American cotton) as the male parent, attempts were made to obtain successful bolls by various methods of treatment of the female stigma before pollination.

The technique adopted was as follows: The flowers of Dharwar No. 1 (*Gossypium herbaceum*) cotton to be used as the female parent were all emasculated in the early morning before the bursting of the anthers. Where various solutions were employed these were painted on to the stigma with a brush about ten minutes before pollination, and were allowed to dry up completely before the pollination was carried out. Fresh pollen seems absolutely essential. Further, when the stigma was painted with distilled water or dew, complete failure resulted. But the following treatments *did* lead to the formation of bolls. In all cases the cross was counted successful if bolls developed and remained on the plant for thirty days after pollination:

(*a*) Pollination without any treatment beyond emasculation led to one successful boll out of 200 flowers pollinated. In this case the flower was pollinated with fresh pollen between 3 and 4.30 p.m.

(*b*) Pollination after removal of the sheath of the staminal column led to two successful bolls out of fifty flowers pollinated (4 per cent.).

(*c*) Pollination after painting the stigma with extract made from the stigma and petals of the male parent led to two successful bolls out of fifty flowers treated (4 per cent.).

(*d*) Pollination after painting the stigma with 2 per cent. cane sugar solution gave one successful boll out of fifty flowers treated (2 per cent.).

(*e*) Pollination after painting the stigma with cane sugar dissolved (1½ per cent.) in extract from the stigma of the male parent led to three successful bolls out of fifty flowers treated (6 per cent.).

(*f*) Pollination after painting the stigma with citric acid solution (1½ per cent.) gave twelve successful bolls out of 100 flowers tested (12 per cent.).

(*b*) Pollination after painting the stigma with a solution of 1 per cent. citric acid and 0·5 per cent. cane sugar solution gave twenty successful bolls out of 100 flowers tested when the operation was done at 4 p.m. (20 per cent.), and two successful bolls out of twenty-five flowers treated when the operation was done at 9·30 a.m. (8 per cent.).

One hybrid plant was raised in 1925-26, and grew with very great vigour, producing 532 flowers during the season, but not one single successful boll was obtained. This is in accordance with the experience of Zaitzev, but the cause of the failure is as yet quite unknown. The external part of the flowers did not show any defects or malformations, and there was proper development of pollen. The anthers appeared quite healthy, and both the pollen grains and ovules did not show any obvious defects.

**308. The Effect of Spacing and Time of Thinning on the Yield, Growth, and Fruiting Characteristics of the Cotton Plant in 1925.** By R. H. Stansel. (*Texas Sta. Bull.*, 360, 1927. Abstr. from *Exp. Sta. Rec.*, 57, 6, 1927, p. 527.) Spacing and thinning tests with Startex cotton at the station in 1925, an unusually dry year, are reported as supplementing previous work. Plants spaced 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, and 36 inches apart in 3-foot rows were thinned normally at the usual chopping time when they had from four to six leaves, and twenty-eight days later when about 6 inches high and squares were forming. Late thinning resulted in cotton plants with fewer branches, particularly vegetative branches, shorter branches, and with first branches higher from the ground, and the plants were smaller both in height and diameter than plants thinned at the normal time. Cotton thinned at the usual time bloomed and opened bolls earlier, and also produced an earlier crop and larger yields than the late thinned cotton. Close and medium spacings, from 9 to 18 inches, made the earliest crop. The size of bolls generally rose as the distance between plants was increased. No advantage appeared to be gained by late thinning. If late thinning is necessary more plants than usual should be left in the row, since more stunted cotton plants can be left on an acre without crowding than plants which grow normally.

**309. Some Effects of Late Defoliation on Cotton.** By C. A. Ludwig. (*S. Carolina Sta. Bull.* 238, 1927. Abstr. from *Exp. Sta. Rec.*, 57, 7, 1927, p. 630.) Observations on cotton in dry and in moderately and heavily irrigated plants, with plants normal and also defoliated either August 20 or September 10, 1925, showed that defoliation reduces the yield both in size and number of bolls if done long enough before maturity. Lint from plants defoliated early was generally weaker and graded lower than that from plants defoliated late, which in turn was considered inferior to the produce of normal plants, particularly in the late pickings. Differences in staple length were not significant provided the lint was not gin cut. Late defoliation on moist soil resulted in the death of most of the branches and many plants, but this did not happen on dry soil or with early defoliation. Defoliation seemed to delay rather than hasten maturity, and the harmful effects on yield and rate of maturity appeared to increase according to the earliness of defoliation before the crop ripens. Attacks of leaf-eating insects, such as the Cotton Leaf Worm, should be regarded only as misfortune.

**310. Inheritance of Rate of Shedding in a Cotton Hybrid.** By T. H. Kearney and R. H. Peebles. (*Jour. Agr. Res.*, U.S. 34, No. 10, 1927. Abstr. from *Exp. Sta. Rec.*, 57, 7, 1927, p. 622.) Observations on $F_3$ progenies and $F_2$ plants of the cotton hybrid Pima Egyptian × Acala, which had shown respectively high, intermediate, and low rates of shedding, afforded conclusive evidence that the shedding of flower buds and young bolls is partly determined by genetic factors. The positive correlation between rates of bud shedding and of boll shedding in both $F_2$ and $F_3$ further confirmed this conclusion. Apparently the inherited tendency to a high or a low rate of shedding expresses itself in abscission both before and after anthesis. The data did not suggest a satisfactory explanation of the tendency to greater sterility in $F_3$ than in $F_2$.

[*Cf.* also Abstr. 428, vol. iv.]

**311.** INHERITANCE OF THE NUMBER OF BOLL LOCKS IN COTTON, AND THEIR RELATION TO YIELD. By R. K. Kulkarni. (Abstr. from *Agr. J. of India*, vol. xxii., Pt. 3, 1927, p. 192.) Evidence is given to show that parental forms can be extracted and bred true, and newer forms, having intermediate values other than the parents, can also be got breeding true. Four-locked bolls on an average give 34 per cent. more seed cotton than three-locked bolls.

## *LEGISLATION.*

**312.** AUSTRALIA. *Quarantine Proclamation No.* 176 of November 16, 1927, gives the modified conditions under which cotton seed and cotton lint may be imported into Australia.

**313.** UNITED STATES. *Quarantine on Account of the Pink Bollworm Revised. Notice of Quarantine No.* 52 (*Revised*). *Rules and Regulations Supplemental to Notice of Quarantine No.* 52 (*Revised*). (*U.S. Dpt. Agr. Fed. Hortic. Bd.*, Washington, D.C., 1927. Abstr. from *Rev. App. Ent.*, xv., **12**, 1927, p. 669.) To prevent the spread of *Platyedra gossypiella*, Saund., the States of Texas, New Mexico, and Arizona are quarantined, and certain areas in them regulated from August 1, 1927. Stalks, bolls, and other parts of the cotton plant, and gin waste, may not be moved interstate from regulated areas, and seed cotton may only be moved for ginning. Cotton seed and cotton-seed hulls, cake and meal, may only be moved after satisfactory sterilization. Cotton lint may only be moved after satisfactory compression and disinfection. Wrappers, vehicles, etc., used in connection with cotton may only be moved after satisfactory disinfection. Cotton permitted to be moved must be plainly labelled as directed. The original Notice of Quarantine and previous regulations are superseded by this revision.

[*Cf.* Abstr. 117, vol. iv., p. 85.]

**314.** UNITED STATES. *Quarantine on Account of the Thurberia Weevil. Notice of Quarantine No.* 61 (*Revised*) *with Supplemental Rules and Regulations* (*Revised*). (*U.S. Dpt. Agr. Fed. Hortic. Bd.*, Washington, D.C., 1927. Abstr. from *Rev. App. Ent.*, xv., **12**, 1927, p. 631.) The areas in Arizona quarantined on account of *Anthonomus grandis thurberiæ*, Pierce, by Quarantine No. 61, which is superseded by this revision, are extended owing to further infestation, and, in addition to the disinfection of cotton lint moved interstate, its compression is also required.

## *CHEMISTRY AND PHYSICS IN THEIR APPLICATION TO COTTON PROBLEMS.*

**315.** RAW COTTON FAULTS. By K. A. Tchapkovski. (*Bibliotheka Chlopkowogo Dkela*, No. 6, 1927. Abstr. from *Jour. Text. Inst.*, xviii., **12**, 1927, A. 428). The defects occurring in raw cotton have been investigated and classified. The distribution of defects in samples of cotton and of waste, taken at various stages of the manufacturing process from the raw material to the finished card sliver, has been determined, and is shown in extensive tables. Neps and motes are the most dangerous impurities for the spinning process, since only these are found in the card sliver and can get through to the roving.

316. COTTON YARN. TENDERING BY ACID. By F. C. Wood and E. Butterworth. (*J. Soc. Chem. Ind.*, 1927, **46**, pp. 375-8T. Abstr. in *Jour. Text. Inst.*, xviii., **12**, 1927, A. 426.)

317. ACTION OF SUNLIGHT ON COTTON. By G. Barr and I. M. Hadfield. (*J. Text. Inst*, 1927, **18**, T. 490-493.)

318. COTTON CELLULOSE. PREPARATION. By W. Kershaw *et al.* (Abstr. in *J. of Text. Inst.*, xix., **1**, 1928, A. 8.)

319. THE MEASUREMENT OF THE FLUIDITY OF COTTON IN CUPRAMMONIUM SOLUTION. By D. A. Clibbens and A. Geake. (*Shirley Inst. Mems.*, vol. vi., December, 1927.)

320. IMMUNIZED COTTON: DYEING. By Sandoz Chem. Co., Ltd., and A. E. Woodhead. (Abstr. in *J. of Text. Inst.*, xviii., **11**, 1927, A. 379.)

321. STRENGTH AND FINENESS IN COTTON HAIR. By J. Dantzer and O. Roehrich. (*L'Ind. Text.*, 1926, **42**, pp. 207, 264. Abstr. from *Agr. J. of India*, vol. xxii., Pt. 5, 1927, p. 390.) The results reported by Kuhn are adversely criticized, and a scheme for establishing the staple length and uniformity, fineness and strength of a cotton in about two hours, including half an hour for the preparation of a Baer diagram, is described. The strength in grammes is first determined, using "the well-known Yves Henry apparatus," which is ostensibly an O'Neill apparatus. Since the measurements are made on the middle cm. of the hairs, they represent the strength in the median zone. The strength per sq. mm. is then determined as follows: Two parallel lines 1 cm. apart are drawn on the surface of a cork, and two slits are cut in its edges perpendicular to the lines. A prepared pull of cotton is inserted in the slits and cut along the parallel lines. One thousand of the centimetre pieces are counted and weighed, and from the weight the metric number is calculated, thence the breaking length and strength per sq. mm. This is not, however, sufficient to characterize a cotton exactly, for the metric number is that of the median zones only. The average strength for the whole hair is obtained by counting out a sufficient number of hairs of, say, the 25 mm. region of the Baer diagram, to give a length of 10 mm. as before, weighing, and calculating its strength by simple ratio from the result of the Yves Henry test. It is the strength of the whole hair which should be used in formulæ for calculating the strength of yarns, such as that of Gegauff. Results are tabulated for twelve cottons of varied type. They show that the average strength for short staple cottons is only 33 kg. per sq. mm., for medium American 39 kg., for medium Egyptian 45 kg., and for the long staple cottons is still higher. There is an average diminution of strength of 28·2 per cent. when the whole hair is considered instead of the median zone, and the time required for determining the average number or strength of a cotton can be shortened by simply diminishing the weight of the 1,000 centre zone pieces by 28 per cent. and calculating the ratio. For the determination of "fineness" in the median zone and considering the whole hair, surface area is calculated from the appropriate weight, 5 per cent. of this value is added to allow for the lumen, and from a graph connecting area of section and diameter of circumscribing circle, calculated on the basis that cross-sections occupy 57 per cent. of the area of the circle containing them, the diameter is read directly. The method of deducing the 57 per cent. is shown.

322. EGYPT. THE STUDY OF QUALITY IN THE SPINNING OF COTTON. (Extr. from the *Br. Cham. of Comm. of Egypt, Mnthly. Jour.*, xv., **1**, 1928, p. 5.) The following is an abstract of a lecture delivered before the Cairo Scientific Society in December last by Dr. W. Lawrence Balls, F.R.S.

Dr. Balls prefaced his remarks by stating that these studies had been pursued in the laboratory and mill since the time when he last attended a meeting of the Cairo Scientific Society—*i.e.*, fourteen years ago. Their aim was to trace the connection between the properties of cotton and the properties of the yarn made from that cotton. Even in 1913 it had been suspected that hand and eye judgment of quality was not infallible, and it was this suspicion that initiated these studies in collaboration with the late Mr. J. W. McConnel. Soon after the commencement of the research it became apparent that less was known about the yarn than about the cotton of which it was composed. Gradually the essential peculiarities of the twisted structure of yarn were appreciated, and after the self-regulatory properties of this structure had been realized it became possible to trace the steps by which the strength of yarn made with any given structure were related to various properties of the cotton hairs used. Strength in yarn was in essence the same as the strength of a chain composed of links of various strengths; great diameter variations were shown even by the best yarns, but the pure statistical theory of weak links could not for years be applied to " singles " yarn, because the weak links shifted from place to place during the readjustment of structure which took place under load. Experiments were shown to demonstrate this readjustment process, and the real meaning of yarn " strength " was analyzed by diagrams of special testing methods which eventually connected the ordinary mill tests to the hair properties.

After pointing out that, in one sense, the properties shown by " singles " yarn as such in the mill testing-room were unimportant, because " singles " yarn was only a temporary arrangement of the cotton, pending its construction into double yarn, sewing cotton, and knitted or woven fabric, the lecturer stated that, of the four chief hair characters now recognized, three were more important than the well-known one of length. These three were: the weight of a unit length of the average hair, or fineness; its intrinsic strength, or breaking load expressed in terms of unit hair-weight; and an imperfectly understood character of slipperiness, which helped towards uniform arrangement of hairs in preparing for the final twisting operation. The connection of these to judgments upon fineness and strength, feel and suppleness, in the hands of the expert grader was indicated, and some of the new apparatus for measuring these hair characters was demonstrated.

It would seem likely that the main outlines of the " science " of cotton-spinning were now available for further study and use. Also, it was probable that exact knowledge of the properties of the cotton itself might become a better guide to the quality of goods manufactured from it, than the present crude tests applied to spun yarn.

323. THE EFFECT OF SUBJECTING COTTON TO REPEATED BLOWROOM TREATMENT. By A. J. Turner. (*Bull. No.* 10, *Tech. Ser. No.* 5. Indian Central Cotton Committee, 1927.) A description is given of tests carried out to determine the effect of repeated treatment in the Crighton opener, or in the scutcher, of baled cottons containing a large percentage of foreign matter. Duplicate lots of three different cottons—viz., 289F, 285F, Hagari 25—were respectively given two, three, and four treatments in the Crighton opener. One of the cottons was also given the normal treatment in the Crighton opener, but successive samples were passed through the scutcher three, four, and five times respectively. Each lot of each cotton subjected to each treatment was spun into three different counts of yarn. Observations were made as to the behaviour of the cotton during working, and a record was kept of the number of breakages sustained on the ring frame during the spinning of each yarn. Spinning test results are given showing the waste percentages and the various yarn-test results, each yarn being subjected to 50 lea tests, 100 tests of single thread strength and extension, and 80 twist tests; each yarn was also classified according to its evenness and neppiness.

The results of the tests show that three or four treatments in the Crighton opener, as compared with the normal two treatments, yield an increase of only about ¼ per cent. in the total waste for each additional treatment; otherwise, the extra treatment makes practically no difference either to the behaviour in spinning, to the appearance of the yarn—including its evenness and neppiness—or to the strength of the yarn. The effect of additional scutching was very similar to that of additional Crighton-opening.

It is pointed out that the results relate to small-scale tests, and that when cotton is being passed through in bulk somewhat different results might be experienced; in particular, if there should be a lack of uniformity in the flow of the cotton, such as to cause intermittent accumulation in the Crighton opener, damage to the cotton staple might ensue. Reference is also made to the possible effects of different beater speeds, settings, and formation of the grids of the opener. The chief conclusions drawn are: (1) That so long as the cotton passes uniformly through the blow-room, repeated opening or scutching effects a slight improvement in cleaning without detriment to the strength of the yarn; and (2) that once cotton containing foreign matter is pressed into bale form it may be very difficult, if not impossible, to remove the foreign matter completely—especially if it consists of fragments of seed-coat—so that the appearance and value of the yarn vary accordingly.

324. SPRAYING OF COTTON. (Abstr. from the Rpt. of the *Eighth Ann. Gen. Mtg. of the Br. Cot. Indus. Res. Asscn.*, October, 1927.) From the report of the Director we quote the following: "It has been claimed that spraying cotton during the opening process with a small amount of a special oil will lessen the dust in card-rooms. The process is now under observation in certain mills, and it seems that this object is really attained by the removal of a certain amount of dust in the blow-room which would otherwise be carried forward. When the trunk of the opener is horizontal or inclined at a slight angle, only a small proportion of the oil supplied in the spray goes forward on the cotton, and at least four-fifths of the oil highly impregnated with dust collects in the trunks. Even when the oil on the cotton is only about one-twentieth of 1 per cent. of the weight of the cotton, it would seem that the yarn spun is slightly weaker and less regular than when oil is not used."

325. COTTON WASTE: MANUFACTURE. By H. Richards. (*Leipziger Monats. Text.-Ind.*, 1927, **42**, 245-6. Abstr. in *Jour. Text. Inst.*, xviii., **12**, 1927, A. 403.) Some general remarks on the spinning and weaving of cotton waste. On the question of using a softener, the author recommends a mixture of 2 parts olive oil softener ("olivinschmälze") and 1 of olein, diluted with 3 to 5 parts of warm water.

326. COTTON WASTE: SOUND ABSORPTION. By E. T. Paris. (*Proc. Phys. Soc.*, 1927, **39**, 269-295. Abstr. from *Jour. Text. Inst.*, xviii., **12**, 1927, A. 423.) The most absorbent surface which has so far been tested consisted of a thickness of 4 inches of loosely packed cotton waste, held in place by wires stretched across it. Measurements at 512 vibrations per second gave the coefficient of absorption as 0·91.

## *MISCELLANEOUS.*

327. AMANI INSTITUTE: PROBLEMS TO BE TACKLED. (Abstr. from *East Afr.*, iv., **177**, 1928, p. 697.) One of the immense tasks to be tackled by the Institute is that of defining and mapping the soil types of the East African Dependencies, the objects being to establish an accurate soil survey and to determine the interaction of climate and soil. The results will, of course, be valuable to agriculturists, who are to day often without exact knowledge of even primary matters concerning the crops which they are cultivating.

328. COTTON STATISTICS: THEIR RELATION TO MARKETING AND MARKET ESTIMATING. By F. W. Tattersall. (Abstr. in *J. of Text. Inst.*, xviii., **11**, 1927, A. 390.)

**329. THE COTTON TRADE STATISTICAL BUREAU.** By E. R. Streat. (Abstr. from *Jour. Text. Inst.*, xviii., 12, 1927, P. 253.) The Cotton Trade Statistical Bureau owes its establishment to a proposal first made by the Manchester Chamber of Commerce, and laid before the Joint Committee of Cotton Trade Organizations. It met with immediate approval from that body, who used their influence with the organizations they represented in order to secure promises of financial support sufficient to ensure a trial period of three years' work. When the necessary groundwork has been done, the Bureau proposes to issue to its subscribers a bulletin of statistical information relating to all sections of the textile industry, to deal with markets and the influences which affect them, with comparative production in the leading textile countries, and with such influences outside the textile industry as are likely to affect its prosperity.

**330. THE GEOGRAPHICAL BASIS OF THE LANCASHIRE COTTON INDUSTRY.** By H. W. Ogden. (Abstr. from *J. of Text. Inst.*, xviii., 11, 1927, T. 573.) An interesting investigation which leads to the following deductions: The cotton industry of south-east Lancashire, so far as this study is concerned, would seem to have its basis on—

(1) The geological structure of the area, with its gift of soft-water supplies fairly evenly distributed over the year.

(2) The meteorological elements of a bountiful rainfall carried to its hill country, and occurring in every month, together with a warm, moist atmosphere.

(3) A fine natural gateway through the Mersey estuary to the cotton-fields on the one hand, and the consumers of the finished fabrics on the other.

Historical causes have also played their part. This, however, is another line of investigation well worthy of careful research. The effect on humanity has been to create within the Mersey and Ribble Basins one of the most densely populated areas of the world, where there is a specialization of locality in industry with a corresponding complexity of regional activities and functions.

**331. MECHANICAL USE OF COTTON.** (Abstr. from *Text. Rec.*, xlv., 537, 1927.) Mr. E. C. Morse, in charge of the New Uses Section of the Cotton Textile Institute, states that 30,000 square yards of cotton material were used in making the approaches of a new tunnel waterproof. The cloth was treated with an asphalt preparation which increased its resistance to moisture, and was laid in various thicknesses, ranging from two to six coatings of fabric. It is stated that cotton fabrics are extensively utilized in lining the foundations of bridges, subways, and tall buildings by engineers, who believe they make construction safer and more permanent. Highway officials are also experimenting with the use of heavy cotton fabrics in road construction.

**332. NEW SPOT COTTON MARKET.** (Abstr. from *Text. Rec.*, xlv., 538, 1928, p. 83.) The Manchester "Spot" Cotton Market opened for business during the past month. Practically all the Manchester merchants and brokers, who number over sixty, are co-operating in the scheme. Bolton and Oldham spinners are promising their support.

**333. THE POST-WAR DEPRESSION IN THE LANCASHIRE COTTON INDUSTRY.** By Professor G. W. Daniels and J. Jewkes. A paper read before the Royal Statistical Society in January last. The subject is dealt with as follows: An investigation of the causes and character of the depression in the Lancashire cotton industry since 1920. Production and exports. Location of the depression. Analysis of unemployment. General causes of the depression. "Margins" between raw cotton and yarn in American and Egyptian sections. Finance of the industry.

**334. THE LANCASHIRE COTTON TRADE: ITS PRESENT BURDENS AND SUGGESTED REMEDIES.** By J. Crompton. (Abstr. in *J. of Text. Inst.*, xviii., 11, 1927, P. 240.)

335. THE TRADE SURVEY. By F. Hall. (Abstr. in *J. of Text. Inst.*, xviii., 11, 1927, A. 390.)

336. USE OF TRADE MARKS IN THE COTTON INDUSTRY. By J. Rankine Finlayson. (*Man. Guar. Coml.*, xv., 388, 1927, p. 601.)

337. THE COTTON FUTURES MARKET: WHAT IT IS AND WHAT IT DOES. By W. R. Meadows. (Abstr. from *Int. Cot. Bull.*, vi., 21, 1927, p. 59.) An interesting article, which will help to make clearer to the outsider this part of the trade in cotton, which is usually so difficult to understand.

338. PHYSIOLOGICAL EFFECTS OF TEMPERATURE AND HUMIDITY ON OPERATIVES. By R. R. Sayers and S. J. Davenport. (*Bull. Hygiene*, 1927, 2, from *Pub. Health Rep.*, Wash., 1927, 42. Abstr. in *Summ. Curr. Lit.*, viii., 2, 1928, M. 3.)

339. INTERNATIONAL INSTITUTE OF AGRICULTURE, ROME. In a note received from the Editor of the *Int. Rev. of the Sci. and Pract. of Agriculture* it is pointed out that until recently the Institute has lacked an important active policy, and has been obliged to devote its activities chiefly to scientific work and to statistics and documentation. This situation is now being altered, and it is being attempted to make the Institute more living, a centre for the agricultural work of the world, and a meeting-place for all who live by agriculture, where they can find help and direction. A Commission of Associations and a Scientific Council have been formed, and have commenced work with Committees upon Agricultural Labour, Meteorology, Plant Pests, and so on.

340. THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD. From the Principal's Report for 1926-27, we learn that the Associateship of the College has been granted to twenty-three students, ten of whom are ex-students of the Empire Cotton Growing Corporation. The Report records further progress in all departments, and a list is given of the papers published during the year, and the journals in which they have appeared.

341. THE USEFUL AND ORNAMENTAL PLANTS OF TRINIDAD AND TOBAGO. By W. G. Freeman and R. O. Williams. (Obtainable from the Govt. Printing Off., Port-of-Spain, Trinidad. Price 2s. 6d.) A convenient dictionary of the various plants of Trinidad, whether native or introduced, with useful information about each.

## *ADDENDA*

[Received on the eve of going to press.]

342. STUDIES ON THE TRANSPORT OF CARBOHYDRATES IN THE COTTON PLANT. I. A STUDY OF DIURNAL VARIATION IN THE CARBOHYDRATES OF LEAF, BARK, AND WOOD, AND OF THE EFFECTS OF RINGING. By T. G. Mason and E. J. Maskell. (*Annals of Botany*, vol. xlii., No. 175, January, 1928.) The general outline of the work that these investigators are carrying out was included in a paper published in this Review in October, 1927 (vol. iv., p. 330), and the present publication is the first to contain full details. The following summary is given.

"The experimental work described in this paper is an attempt to study the phenomena of carbohydrate transport by means of observations on sugar concentration in the sap of the leaf and of the tissues (bark and wood) assumed to be conducting. In addition estimations of total carbohydrate content of the stem tissues at relatively short time intervals are used to obtain data as to amount or rate of transport under specified conditions. The main conclusions are summarized below:

"A. *Methods.*—It is concluded that the variation in carbohydrate content or in moisture content of a mature plant organ or tissue is more accurately expressed on the basis of residual dry weight (total dry weight less carbohydrates) than on the basis either of fresh weight or of dry weight.

"B. *Diurnal Variation in Carbohydrates of Leaf and Bark, Wood and Boll.*—(1) Diurnal variations in the concentration of total sugars in the leaf are more highly correlated with variations in concentration in the bark than in the wood.

"(2) Diurnal variations in the bark show a significant lag on those in the leaf.

"(3) The diurnal variations in concentration of total sugars in the bark are in large measure due to variations in sucrose concentration.

"(4) Variations in rate of transport of sugar into the boll are significantly correlated with variations in sucrose gradient from bark to boll.

"(5) The rate of transport of sugar into the boll is about four times as rapid by day as by night.

"C. *The Channel of Transport.*—(1) Ringing a stem below the foliage region interrupts the downward transport of carbohydrates across the region of the ring. As this interruption occurs within a period of a few hours from the time of ringing, it is concluded improbable that carbohydrates are transported in the outer layers of the wood and that the interruption on ringing is due to the blocking of the tracheæ by substances exuded as a result of morbid changes in the neighbouring cells.

"(2) Ringing does not interrupt the transport of carbohydrates into the stem immediately above the ring, nor apparently does it affect transport out of the stem immediately below the ring.

"(3) Ringing causes an accumulation of carbohydrates not only in the bark and wood just above the ring, but also in leaves about 2 feet distant from the ring.

"(4) As ringing interrupts the downward transport of carbohydrates in a stem and does not interrupt the downward movement of a dye in the wood, it is concluded that the two processes are fundamentally different.

"(5) Though ringing markedly increases the concentration of sugar in the wood as a whole above a ring, yet the concentration of sugar in the transpiration current was not found to be affected.

"(6) While complete removal of the bark interrupts the transport of carbohydrates, the insertion of a ring of paraffined paper between bark and wood permits of transport at nearly the normal rate. Contact between bark and wood is thus not essential for transport.

"(7) When wood and bark are completely separated, movement of sugar takes place through the bark at nearly the normal rate. Movement through the wood could not be established. It is concluded that the downward transport of carbohydrates occurs in the bark.

"(8) Evidence presented on longitudinal gradients of sugar concentration in the bark suggests that concentration gradients play a part in determining rate of movement."

**343.** We have received from the Secretary, London School of Hygiene and Tropical Medicine, a notice regarding instruction in tropical hygiene, from which we quote the following:

"The need for instruction in hygiene in the case of every man going out to the tropics is, or should be, self-evident. He should be thoroughly well informed with regard to such everyday matters as to what he should eat and drink, and what he should wear, and especially what he should avoid. He should know what kind of housing conditions are best suited to tropical climates, and should be instructed with regard to the storage and preparation of food, and the supervision of the living habits of native servants. A simple knowledge of questions of water supply and sewage disposal is necessary, and something of the habits of flies, mosquitoes, and other insects, and of the ways in which they spread disease. Any courses of instruction might well also include a short account of some of the more familiar diseases, with simple methods of self-treatment, but at the same time it would not be a wise proceeding to fill the mind of the young traveller with terrifying pictures of tropical maladies."

It is understood that the authorities of the London School of Hygiene and Tropical Medicine will, in the light of suggestions made at a conference held recently, now proceed to make arrangements for courses of lectures, and that an announcement with regard to the provisional arrangements for the next twelve months may shortly be expected. At the end of that time the School will enter into occupation of the very fine premises now being erected in Bloomsbury, with funds amounting to about £500,000 provided by the Rockefeller Trustees under the terms of an agreement with the British Government. Enquiries regarding the courses should be addressed to the Secretary, London School of Hygiene and Tropical Medicine, Malet Street, London, W.C. 1.

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# PERSONAL NOTES

We offer our congratulations to Lord Lugard on receiving the honour of a Barony of the United Kingdom. Lord Lugard as a Vice-President of the Council and Chairman of the West Africa Sub-Committee of the Corporation has rendered valuable assistance to that body, and his help is greatly appreciated.

## OFFICERS ON LEAVE.

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes "home" on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton. The Corporation would consequently much appreciate the courtesy if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would call at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street) immediately opposite to the offices of the Crown Agents for the Colonies.

At the date of writing the following officers are on leave in England from cotton-growing countries:

| | |
|---|---|
| Ceylon | Mr. T. H. Parsons. |
| Gold Coast | Mr. G. S. Cotterell. |
| „ „ | Mr. T. Hunter. |
| „ „ | Mr. J. T. H. Stein. |
| Iraq | Mr. D. D. Paterson. |
| Kenya Colony | Mr. E. J. Hall. |
| „ „ | Mr. A. S. Hartley. |
| Nigeria | Mr. D. P. Stanfield. |
| „ | Mr. T. Thornton. |
| Tanganyika Territory | Mr. W. J. Hill. |
| „ „ | Mr. R. W. R. Miller. |
| „ „ | Mr. C. M. H. Sutherland. |

Mr. W. J. Jenkins, Deputy Secretary of the Indian Central Cotton Committee is also on leave in England.

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THE
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# THE COTTON INDUSTRY ACT

AMONG other obstacles that interfere with the further progress of the cotton industry, there lies one that may be imagined as a broad stream that must be crossed. On the near side one pictures the industry as it exists at present, liable to great fluctuations in supply, and in the cost of that supply, owing to the too great dependence that has to be placed upon the one great source of raw cotton at present available. Let there occur unusual activity of insects, early frosts or other climatic disadvantages, great prosperity of the local spinning industry, or other easily conceived eventualities, and down goes the supply of cotton available for export, and up goes the price; and Lancashire must pay it, or go without the cotton.

But there is no absolute necessity why such a state of affairs should continue indefinitely. On the other side of the river that must be crossed one pictures the growth of cotton in so many different parts of the world, with such different conditions and climates, and in such quantity in each, that an excess or a deficit in one will usually be made up by a deficit or an excess in another, and will have but a slight effect, whether upon the supply of cotton, or upon the price, while at the same time the latter will be as low as is consistent with a satisfactory return to the cultivator. [Incidentally, this will involve, among other things, a great improvement upon the transport facilities at present available in most places.]

The passage across the river, from the one condition to the other, will be a slow, laborious, and troublesome affair, but it has now very definitely begun. The team, so to express it, has entered the river. We have the authority of a great man for the maxim that it is not wise to swap horses under such conditions, and it is at least equally inadvisable to get rid of the animals altogether. It is a matter which redounds to the credit of the workers in the cotton industry—from the simplest hand-worker to the most highly placed administrative officer—that they have clearly realized this fact. In spite of the great difficulties under which the industry is at present struggling, neither the one nor the other has wavered in support of the Cotton Industry Bill, which imposes upon the industry, at its own desire, a tax for the support of the necessary research and administration to effect the change outlined above, a change which involves the growing of much cotton in as many portions of the Empire as may be possible.

As above mentioned, this great change in the geographical distribution of the cotton-growing industry has now definitely begun. During the last season, the Empire, independently of India, produced over 400,000 bales of cotton of good quality, on the whole rather better than the Middling American which makes the cotton of everyday use. Large quantities were also produced by Brazil, Peru, and other countries. True it is that not all of the Empire-grown cotton goes to Lancashire; but the growers, who are British subjects, get their price for the cotton just the same. Production of cotton in any fresh place helps to steady the supply, and the price. If Lancashire wants the cotton, she can always have it by payment of the price, while its simple production benefits her indirectly, even if she never sees it.

The work of the Empire Cotton Growing Corporation is just beginning to show good results, and the production of cotton in the Empire has now reached figures that are quite appreciable. To go back upon this work now would be a very retrograde step, and the industry is to be congratulated that this has not only not occurred, but has not come within measurable distance of occurring. By the end of another five years there is reason to hope that the present production of cotton within the Empire will have doubled itself at least, in which case it would reach to about 25 per cent. of the consumption in Lancashire. When it reaches 50 per cent., there will be a great increase in stability of supply and price.

But in addition to this, most of the Empire cotton is of distinctly better quality than that in most common use at the present time, and as it appears upon the market in larger and larger quantity it will make it more and more easy for Lancashire to spin finer counts—a change which is being more and more clearly indicated as probable and necessary. The rest of the world has taken to spinning its own coarser qualities of cloth, and that frequently at a cost with which Lancashire may not be able to compete.

How difficult and troublesome the passage from one side of the stream to the other really is, and by consequence what a great mistake it would be seriously to curtail the work in progress, may be gathered from the "Review of the Situation in the Principal Cotton Growing Territories of the Empire . . ." recently published by the Corporation. Climatic difficulties occur everywhere, and are usually serious enough to involve the breeding of suitable local varieties for each country before full success can be hoped for. In many places insects —*e.g.*, the jassid in South Africa—are very troublesome, and involve the production of resistant forms. In other places labour or transport difficulties form the great obstacle, or the obtaining of a good water-supply by irrigation. And so on: nowhere is there any place clearly marked out for the immediate and successful inauguration of cotton-growing. But, on the other hand, there are comparatively few places with suitable climate that do not hold out a hope that they may become in time important sources of supply. Until all have been thoroughly tried out with all the resources placed at our disposal by plant-breeding methods, and by improvements in cultivation, in facilities for transport and marketing, and the rest, effort should not for one moment be relaxed. The success already attained is so considerable that there is now every reason to hope for a production of perhaps 2 to 3 million bales of good average cotton within the Empire (including India) before the lapse of a great period of time. This, added to the increasing production in other new cotton countries, will spread the cultivation over so wide an area with such different conditions of climate, labour, etc., that the alternate periods of glut and scarcity of recent years, with their great variations in price, and their uncertain outlook for the future, should become things of the past, to the lasting benefit of the industry.

# THE MOISTURE REQUIREMENTS OF TROPICAL CROPS

BY

H. MARTIN LEAKE, Sc.D.

Of the requirements for plant growth under agricultural conditions only carbon dioxide, the source of starch and the sugars formed by the plant, is universally present in an abundance sufficient for unrestricted growth. Of other material requirements, soluble mineral salts and organic nitrogenous matter, the quantity present may be insufficient for vigorous growth, as the wide application of manures sufficiently indicates. But there are other, and as essential, requirements if free growth is to take place; of these the following are the more important.

The plant in growing incorporates into its structure the food material formed from the carbon dioxide of the air, as well as water and the salts dissolved therein which are taken up by the roots. The process is a chemical reaction which requires energy, and that energy is derived from light. Like most chemical reactions, too, it takes place only within definite limits of temperature, the optimum temperature varying with different species of plants, and the rate of formation of food material will, other conditions being favourable, vary with the temperature until that optimum is reached. The third essential is water or, better, humidity; for air humidity is as essential a factor as actual soil moisture. The plant is dependent on soil moisture not only as a medium to provide in solution the mineral requirements, but to maintain its tissues in a turgid, or unwilted, condition. It is dependent on air humidity not merely to limit the loss of water contained in the tissues, but to permit the access of carbon dioxide to those tissues in which that gas is converted into starch or sugar; for the mechanism by which the plant controls evaporation of the water contained in its tissues also controls the entry of carbon dioxide. When the evaporation of water is checked, the entry of carbon dioxide is likewise checked.

The essential difference between growth in the tropics and in temperate climates lies in the differences found in the incidence of these three factors, light, temperature, and humidity, under the two conditions. The seasonal variation in the length of day is less marked in the regions bordering on the tropics, and here light is not responsible for any marked seasonal variation in rate of growth, of which it is partly the cause in more northerly climes. Nor, as a rule, do the days of low light intensity, so common in a country like England, occur in the tropics. Light may be said to be adequate within the range of the duration of the day, and it is removed from consideration as a factor limiting growth under tropical conditions.

Temperature, similarly, is adequate and rarely limits the growth of plants adapted to a tropical life. To discuss whether it ever exceeds the optimum, as it undoubtedly does in the case of a temperate plant transplanted into the tropics, would exceed the limits of the present subject, which deals with crops normally grown in the tropics. Such cases, if they occur, are sufficiently rare to be neglected here; moreover, where temperature appears to be excessive, further enquiry will probably disclose the fact that the real factor checking growth is air humidity; for really high temperatures, 110° F. and over, are associated with arid conditions.

Light and temperature thus being ruled out, humidity remains the main natural factor controlling plant growth in the tropics, and it is this essential simplification of the problem that lends importance to the study of the relation between the crop and humidity under tropical conditions. It is under these conditions that the study can be pursued freed from those complications which a deficiency of light or temperature superimposes.

Under natural conditions humidity is dependent on local rainfall; and though exceptions occur in the case of floods, as in Lower Bengal, and under certain special and somewhat exceptional physiographical conditions to which reference will be made later, this may be considered the normal position. Rainfall is, however, a very variable factor, but it is a variability which takes more than one form. In the first place, there is the variability which exhibits itself as intermittence. In no country does rain fall continuously and steadily; it occurs in intermittent showers of greater or less duration and greater or less amount. In the second place, there is that variability which exists between the rainfall of different regions, and which exhibits a definite annual cycle. At one extreme no dry season is demarcated; periods of comparative drought only are to be distinguished from periods of comparative wet. Of such a nature are the regions with dense tropical forests characteristic of the equatorial belt. From these, with infinite gradations of an ever-increasing intensity of the dry season, are to be distinguished the regions with alternations of marked dry and wet, or monsoon seasons; and, ultimately, by a contraction in the duration of the wet season, the other extreme characterized by desert conditions.

It is this seasonal variability which determines the broad outlines of the agricultural practice of any particular region. In the wetter regions are grown such crops as rubber, cacao, and sugar, crops which take twelve months or more to arrive at maturity, and require continuous moisture; in the monsoon tracts are grown seasonal crops like cotton, maize, and simsim (Sesamum), capable of arriving at maturity before the dry season sets in, and crops like coffee, tea, and sisal, perennial crops that is, but crops which are capable of withstanding a period of drought. The growth of crops like sugar may be extended into the monsoon area, where an artificial supply of water is available for their maintenance throughout the rainless period. In this latter case the factor controlling growth may be air humidity. The main features of irrigation and its distinctive characteristics will be considered later.

It is not this seasonal variability, however, that is the main topic of this paper. The object is, rather, to consider that first class of variability which is illustrated by the intermittence of the rainfall. Everyone connected with agriculture is aware of the fact that the quantity of rain is not the only, or even the most important, feature. As important as quantity is distribution. Even in countries like England, where the rainfall is fairly evenly distributed and where individual falls are rarely heavy, the importance of distribution is obvious. In tropical countries, where the falls are commonly much heavier, the distribution becomes all-important. It is a common feature of the Indian monsoon to find that the best agricultural result is obtained from a definitely subnormal fall when this is well distributed. If, as is most desirable, it is attempted to measure the dependence of the crop on the rainfall—in other words, to determine the agricultural value of rain—clearly account must be taken of distribution as well as quantity. The figures of total annual rainfall are not only of little value, but may be actually misleading. At Cherrapunji, in the Assam hills, the annual rainfall averages over 400 inches, and sometimes exceeds 500 inches; yet it is a hill station with a five-month dry period when practically no rain falls. This may be compared with Rio with an average annual fall of some 40 inches. Yet the latter is a perennial garden in which all forms of tropical vegetation flourish. One of the heaviest falls in twenty-four hours, some 41 inches, is recorded in the dry area of Ceylon, while the heaviest fall in the writer's experience, some 21 inches in twenty-four hours, at Cawnpore, equals a somewhat low but totally adequate annual fall for the agriculture of the tract had it been well distributed.

Total annual rainfall was soon seen by those attempting to calculate the agricultural value of rain to offer no guide to the agricultural potentialities of a country, and efforts to arrive at that value have tended to place an increasing importance on distribution. The first serious effort in this direction is that of Rawson, a former Governor of Barbados and President of the Royal Statistical Society. In a report published in 1874 he analyzed the rainfall data of that island, and calculated its influence on the sugar crop. He carried his analysis to the monthly aggregate falls without result, and reverted to the annual total. His very detailed analysis of the data, in a report occupying some 160 pages, may be summed up very briefly; he found that 1 inch of rain was responsible for 800 hogsheads of sugar in the crop yield of the following year. That he found such a relationship with the annual fall is due to the fact that the rainfall of Barbados is very equitably distributed. It is true a relatively dry period exists, but absolute drought is non-existent, while heavy rains—rains of more than 2 inches—are rare, and only associated with cyclonic disturbances which rarely touch the island. Rawson failed to identify a feature of Barbados, to which reference will be made later, dependent on its geological formation and minimizing the effect of such drought as does occur.

Rawson's work antedates the more recent developments in statistical method which are the feature of the end of last and the current century, and further progress awaited that development. This method, the method of correlation, has formed the subject of an article in this journal by Yule and Engledow; it has been extensively employed to determine the dependence of crops on rainfall and, in temperate climates, on temperature. Detailed reference to this work is not possible here; summaries are to be found in papers by Mellish (*Quarterly Journal Royal Meteorological Society*, 1910) and Hooker (*Journal Royal Statistical Society*, 1907, and *Quarterly Journal of Royal Meteorological Society*, 1921). The basis of all these determinations is the division of the period of growth into a number of equal time intervals, varying from six days in some investigations to eight weeks in others. The aggregate fall for the corresponding period of successive years is taken and correlated with the yield, the process being repeated with each period into which the growth season has been divided. An outstanding example of work along these lines is that of Walter and also of Moore.

Walter applied the method to the sugar crop of Mauritius in 1910.

His objective was primarily economic: an effort to work out a basis for the insurance of crops, more especially against the losses due to the cyclonic disturbances which visit that island so frequently. If the loss is to be gauged, some estimate must be made of the yield that would have resulted had the cyclone not struck the island. Though his results were striking they were insufficient to convince the insurance companies concerned that they offered a basis for calculating risks, and the scheme fell through.

Moore, applying the same method to the rainfall and temperature data of the cotton belt of the Southern States of America, evolved in 1917 a system for estimating from those data the yield of cotton, for which he claimed an accuracy greater than that of the official estimate.

In spite of the considerable success which attended the application of the statistical method of correlation, it soon became apparent that the system was far from perfect, the greatest source of error being the undue value—undue, that is, in respect of its real effect—placed upon heavy rain. Much of the recent work, consequently, is found to consist of efforts to discount heavy rain by various systems of what is known as "weighting." Walter, for instance, recognized the desirability of such weighting, and adopted a system which took into account the number of days during which rain fell. His own example may be given as an illustration of the principle of weighting. The different value to be assigned to 5 inches of rain in a month of thirty days, according as it falls on one day or is distributed over twenty days, is given by the following:

5 inches of rain on one day has a relative value of $5 \div 30 = 0{\cdot}167$.
5 inches rain on twenty days has a relative value of $(5 \div 30) \times 20 = 3{\cdot}333$.

More recently Fisher has evolved a newer method, and applied it to an analysis of the rainfall and wheat returns of Rothamsted. The method is intricate, involving polynomials up to the fifth degree, and is one which the writer is quite incompetent to interpret into the language of that large body of the uninitiated to higher mathematics of which he is one unit. His method, however, follows those already described in this, that it takes a six-day time unit of which the aggregate rainfall is employed.

Characteristic of all these applications of statistical method is the division of the crop period into greater or less intervals of time, varying from six days to eight weeks, of which the aggregate rainfall of the interval is taken to measure the effect of rain on the crop without any allowance for a carry-over from one period to the next. By Fisher's method alone is an allowance made. Yet it is clear that the effect of rainfall does not terminate thus abruptly at the end of a period which is, moreover, arbitrarily determined without reference to the developmental stage of the plant. This point was vividly brought home to the writer in the case of the fall of 21 inches already mentioned. This, though a continuous fall, occurred on August 31-September 1, approximately 10 inches falling in each twenty-four-hour recording period. In any system of division of time in which the end of the month is employed as separating the periods, an alteration of a few hours only in the incidence of the fall would have placed the whole 21 inches in an earlier, or a later, period, and materially affected numerical calculations based on the resulting figures. It would appear, therefore, that any system dependent on the use of aggregate falls for arbitrary units of time is open to the criticism that it takes no account of the fact that the effect of rain, while it only commences with the actual fall, continues for a period, indefinite but lengthy, when compared with the time intervals commonly adopted for statistical work.

To meet this criticism the writer has recently developed a method of evaluating the effect of rain which takes into account this essential characteristic. The name "effective rainfall" is applied to a daily figure obtained by adding to the actual rainfall of any day nineteen-twentieths of the figure similarly obtained for the preceding day. For explanatory purposes the method may be applied to the first rain of the monsoon when a dry period sufficiently prolonged to have reduced the carry over to an insignificant figure is followed by a rain of, say, 2 inches. Nineteen-twentieths of 2 inches is 1·90 inches, which amount is carried forward to the next day. If no rain falls on this day, 1·90 inches is the effective rainfall of the second day, and nineteen-twentieths of 1·90 inches, or 1·81 inches, is carried forward to the third day. But if rain, say, 0·50 inch, falls on the second day, the effective rainfall becomes 1·90+0·50=2·40 inches, and the amount carried forward to the third day is nineteen-twentieths of 2·40 inches, or 2·28 inches. In this manner a continuous curve is obtained (*vide* chart) which represents in very graphic manner the moisture conditions of a tract.

The assumption here made is this: of the rainfall of any particular day one-twentieth is lost, or fails to become effective for plant growth, and, of the remaining nineteen-twentieth, a like fraction fails to become effective during the second day, and so on. The successive fractions represent the loss due to run-off, percolation, direct evaporation from the soil and absorption by the plant. Clearly the loss is affected by such factors as temperature, and the same amount of rain is responsible for a more enduring effect in a temperate climate like England than in the tropics, and in the cooler months of the year than in the summer. The fraction of one-twentieth is, therefore, only applicable to conditions of fairly high and uniform temperature such as occur in the tropics, and would require modification for the different conditions of temperate climates.

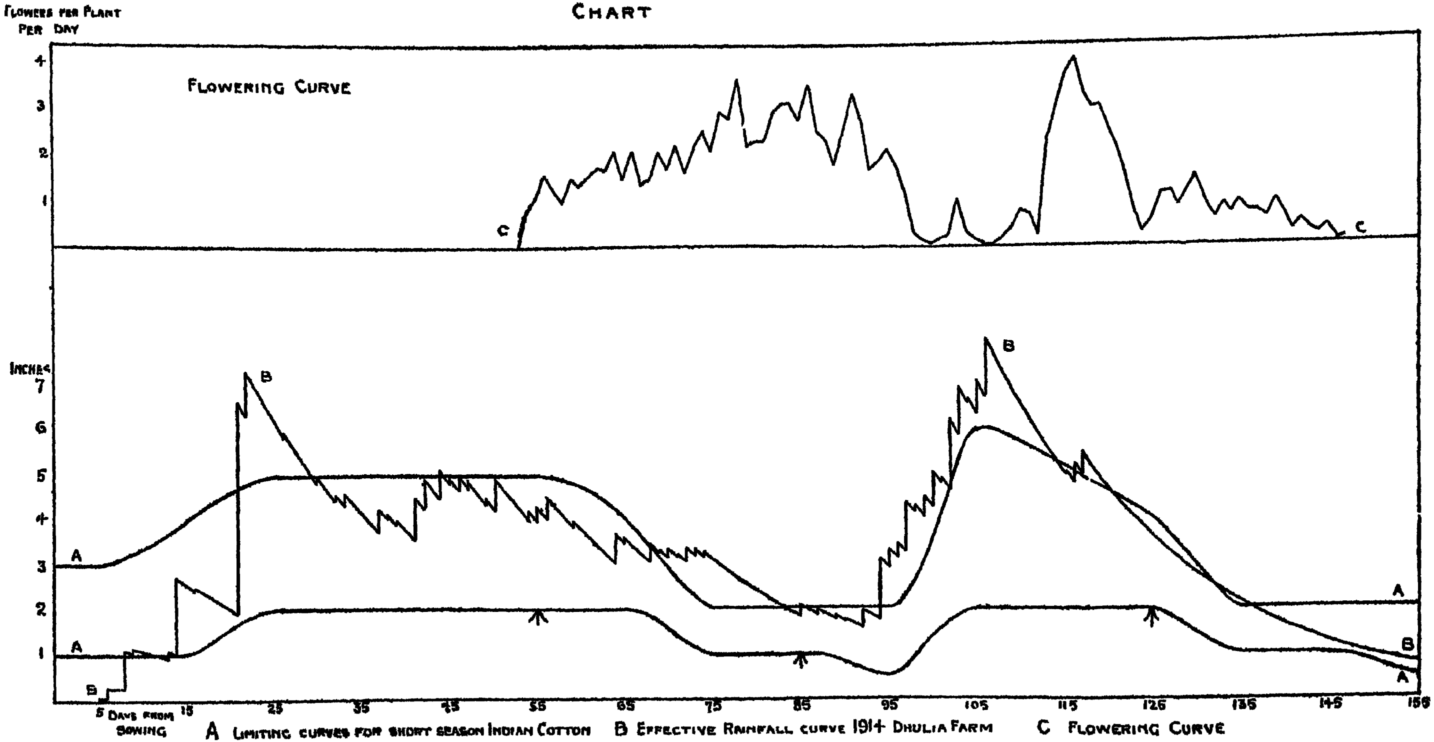
The effective rainfall of any particular day is, thus, a measure of the soil moisture, derived from rain, available for plant growth, and takes into account the cumulative effect of all previous rain. The average effective rainfall for any particular period of days, consequently, affords a better measure of the effect of rainfall on plant growth than the aggregate of the actual daily falls for the same period. Although the method is only a preliminary approximation, undoubtedly capable of improvement and on many points open to criticism, it has been found to be of considerable use in attacking economic problems, a few of which may be indicated.

The Governments of the various Provinces of India publish for trade purposes a series of "forecasts" of the principal crops. In Northern India, the Government of the United Provinces publishes early each year a preliminary forecast of the area under wheat, in which the estimates of the irrigated and unirrigated areas are recorded separately for each of the forty-eight districts. Wheat is sown early in November, and the unirrigated area is largely dependent on the moisture derived from the preceding monsoon which ceases in September or early October. The actual area of unirrigated wheat of the Cawnpore district has been compared for a series of twenty-seven years, first with the total monsoon rainfall, and, secondly, with the value of the effective rainfall on October 15. The former gives a correlation of +0·69, the latter a correlation of +0·82. Practically interpreted, this means that the unirrigated area of wheat can be forecasted some two or three weeks before it is sown, and with an accuracy which is greater than that given by the official system, the results of which, further, only appear some two or three months later. A similar calculation of the unirrigated cotton area of the Cawnpore district, a calculation which, for reasons which cannot be entered into here, is considerably more complex, gives a correlation figure of +0·77. An interesting economic point which has appeared in the course of this enquiry is that, while the irrigated cotton area is largely influenced by the relative price of wheat and cotton, the unirrigated area is not so influenced. Cotton is sown on irrigation prior to the break of the monsoon, and on land which, if not put down to cotton, would probably be left fallow and sown to wheat in the following October. There is here interesting proof of the foresight of the ordinary Indian cultivator, and an indication that he is quite alive to relative values. Further, the dependence of area on price is more marked in the main cotton tract of the Province, in the Aligarh district, for instance, than is the case in the Cawnpore district, where cotton is a less important crop. When, however, the unirrigated area is considered, no such relation between area and price is found. The dominating factor here is the nature of the early rains. If these are favourable, the cultivator will sow cotton up to the limit of his ability, for is not a bird in the hand worth two in the bush? The later monsoon may be unfavourable for wheat, and at the worst, if the cotton crop fail, it will not be too late to plough and sow wheat or at least barley.

The preliminary results here given sufficiently indicate the value of the effective rainfall in forecasting areas, though much remains to be done before any wide application of the method will become possible. Investigations have, however, been attempted along similar lines in the case of yield, and the two analyses undertaken may be briefly described.

The Barbados cane crop is planted towards the end of the year and reaped in February to May; it occupies the ground, therefore, some fifteen months. There is no real dry period comparable to that of a monsoon tract, though the period June to December is definitely wetter than the period January to May. There are three seasons the rainfall of which has been found to affect the crop yield; they are the wet season prior to planting, the dry season subsequent to planting, and the wet season preceding the harvest. The correlations of the average effective rainfalls of these periods with the yield are, respectively, +0·44, +0·42, and +0·76, all of which are significant figures and definitely higher than the corresponding figures for the total rainfall for the corresponding periods. An analysis of Rawson's figures is now being worked out, his report giving the necessary data including daily rainfall returns from 1847 to 1872; but the present results draw attention to a point, not recognized by Rawson, that the rainfall of the wet season prior to planting, and, therefore, two years prior to harvest, has a material effect on the yield. The explanation is probably to be found in the nature of the coral rock of which Barbados is built. By it, to a greater extent than in normal soils, the water is held as in a sponge to be returned to the surface during the succeeding dry weather when the young sets are establishing

CHART


Flowers per Plant per Day
4
3
2
1
Flowering Curve
C
C
Inches
7
6
5
4
3
2
1
A
A
A
A
B
B
B
B
5 Days from Sowing
15
25
35
45
55
65
75
85
95
105
115
126
136
145
156
A Limiting curves for short season Indian Cotton
B Effective Rainfall curve 1914 Dhulia Farm
C Flowering Curve

themselves. A somewhat similar phenomenon is met with in Bihar, where indigo used normally to be sown in March, although there might have been no rain later than early in the October previous, and none could be expected before mid-June. Here, however, the supply of water for germination and growth of the young indigo plant is due to the upward thrust imparted by the head of water in the Hills and derived from the previous monsoon.

One other analysis may be referred to, because it illustrates a further development of the use of the effective rainfall, and, dealing as it does with the cotton crop of the Dhulia farm in the Bombay Presidency, it will be of especial interest to readers of this journal. The general interest, however, arises from the fact that, in this case, there is direct evidence of the evil effect of excessive, as well as deficient, moisture.

The general habit of the cotton plant is too well known to require description here. The essential features are that a period of vegetative growth is followed by a flowering period when, if the fruits set, the food materials formed by the plant are gradually diverted from vegetative growth to the developing bolls. The cessation of vegetative growth which results automatically reduces flower production; but, with the ripening of the first bolls, food material is released for further vegetative growth, and, with it, renewed flowering. The normal flowering curve of the cotton plant is, therefore, bimodal (see chart), and the crop is the sum of the produce of two flushes, though in practice, the product of the first flush only is collected and the crop cut out before the second flush develops. The moisture requirements of the cotton plant differ materially at the different stages of its development. Being sensitive to excessive moisture—it is a common Indian saying that a good cotton year is a half-famine year—it requires adequate, but not excessive, moisture during the first, or vegetative, period, and a relatively dry period during the first flowering period, for too much rain at this stage leads to excessive boll shedding. With the cessation of the first flowering period the crop requires adequate rain to give renewed vegetative growth, and it is even able to withstand heavy rain if this is not too prolonged to damage the ripening fruit; while, with the development of the second flush, a diminution of the rainfall is necessary if the bolls are to mature.

Working from this basis, it has been found possible to draw two curves representing respectively the upper and lower limits of moisture requirement. Where the moisture, as measured by the effective rainfall, falls below the limit given by the lower curve, the plant suffers in yield, as is also the case when the moisture rises above the upper limit. As long as the effective rainfall curve lies between the limits of the two curves the plant suffers no injury, and, hence, by adding the positive divergencies above the upper limit and the negative divergencies below the lower limit, a measure of the divergence of the season from the optimum is obtained. In the case of the Dhulia farm crop a correlation of – 0·70 has been obtained.

The possibility of calculating such a dual effective rainfall curve for a crop, however, has wide implications. The above analysis refers to a plant of the "neglectum" type of cotton with a very short season. It is certain that a similar characteristic curve, and one readily distinguishable from the above, could be worked out for cotton of the American type. The dual curve appears, in fact, to have a specific and even varietal significance. Such a result, if confirmed by further work, would be important. On the available information it is already possible, by working out in the above manner the rainfall data of a tract in which cotton has not hitherto been grown, to indicate broadly the type and with considerable accuracy the best season for sowing. Further work along these lines with the object of determining the curves characteristic of different varieties should render it possible to state on *a priori* grounds the varieties best suited to any particular tract for which the daily rainfall data are available.

Agricultural development, however, is not limited to tracts with adequate rainfall. There are large and important tracts where a deficient rainfall is reinforced by irrigation. Here an entirely new set of conditions arises. Irrigation, like rain, adds moisture to the soil, and provides adequate moisture to the roots, but it has a relatively small effect on air humidity, which may now become the controlling factor of plant growth. The phenomenon is well known to all who have practical experience of agriculture in hot and dry countries. In Northern India the cane crop is planted in February and March, and is kept alive over the succeeding hot weather by irrigation. But, whatever the amount of water supplied, growth is negligible, for the hot dry air induces closure of the stomata, which, in its turn, checks the formation of food materials. Under these conditions no interpretation of irrigation water in terms of rainfall will enable an estimate of yield to be made, for the reason that it is not the available moisture in the soil, of which the effective rainfall is a measure, but the air humidity, which now controls growth.

A most interesting example of what appears to be an illustration of this condition is to be found in the Sudan. The report on the

Anglo-Egyptian Sudan for 1926-27 (published by the Empire Cotton Growing Corporation) contains the following passage:

> One extremely interesting feature was noted, and that was the entirely different behaviour of the cotton on the Gezira Research Farm, compared with the previous year and with former experience in the Gezira.
>
> The difference lay in the fact that the phenomenon of suppression of the lower fruiting branches was practically absent. Effective fruiting branches were commonly produced in the tenth or eleventh leaf axil of the stem, as against the twelfth or fourteenth axil in the previous season's crop. This effect was shared by *all* the cotton plots on the Gezira Research Farm, and by *all* varieties (in different degrees) in those plots. The change would not have been considered very remarkable, if it had not been noted that the plants at the adjoining Barakat Seed Farm did not show it. The behaviour there was that of the normal Gezira type noted in last year's report, fruiting branches being produced in the thirteenth to fifteenth axils, or even higher. An examination of the cotton in the neighbouring areas showed that it agreed with the normal Barakat type.
>
> The improvement in appearance of the crop at the Research Farm was very striking, the usual " legginess " being practically absent. This improvement was accompanied by a very much improved yield, and by an entirely different manner of " arrival " of the crop as compared with Barakat.

There is here a very marked change in habit of the plant from abnormal to normal, a change which is, apparently, due to differences of environment so slight as not to be immediately apparent. On this aspect the report continues:

> The reasons for this difference in behavour are being investigated, and it is hoped to publish the results at a later date, but it would seem probable that they are connected with the presumably higher moisture content of the soil at Wad Medani brought about by an extra watering given in the earlier stages and conserved by more frequent surface tillage, or possibly by a lower soil temperature or air temperature induced by these waterings.

The main present interest of the observations here recorded lies in the fact that the conditions under which the plant is growing at the time when the first fruiting branches are forming appear to be critical; a change, so small as to be far from obvious, being sufficient to produce a marked change of habit in the direction of increased health. The plant is evidently exposed to a water strain; but water strain may be induced either at the point of entry, the root hairs, or at the point of exit, the stomata. In the former it is not necessarily the absolute amount of water contained in the soil which regulates the supply to the plant; it may be the rate at which moisture moves through the soil to replace water taken up by the plant through the root hairs. A strain so induced would, in consequence, assert itself relatively early in heavy soils, such as are characteristic of the Gezira. In the latter case the strain is induced by external factors, air humidity or temperature, the effect of the former being emphasized by air motion—that is, by wind. Within limits, therefore, the water strain may be controlled from either side in a manner similar to that by which the draught to a furnace may be controlled by dampers set either in front of the fire box or in the flue. Temperature and air humidity are both variable factors showing a marked diurnal fluctuation, and it is conceivable that the plant is subjected to a limitation imposed alternately at the roots and at the shoot. It is possible, therefore, that a general increase of air humidity, or a fall in temperature, the effect of which would be to round off the peaks of the evaporation curve, would be effective even if that effect were the indirect one of reducing the plant's drain on the soil moisture. And where the adjustment is so fine as the observations indicate, a very slight change might be sufficient to produce a marked change of habit.

In following this line of thought it is hardly possible to avoid associating the phenomena with another characteristic of the Gezira tract. There is here an area of 300,000 acres of cultivated land, of which some 100,000 acres are under crop, placed in the midst of an extended desert in which the only free water surface is the narrow strip of the Blue Nile. This area, moreover, has only recently been attained. Is it not conceivable that, with this increased area, a general rise of air humidity has resulted which, though too small to be readily detected among the large daily fluctuations, is adequate to produce the observed effect? Such an effect would not be uniformly apparent, and would be likely to occur locally where conditions favour the formation of pockets of relatively still air.

Certain observations of Williams (Bull. 32, Technical and Scientific Service, Ministry of Agriculture, Egypt, 1923) on the conditions under which cotton is grown in different countries would seem to point in the same direction. In this note he draws attention to the similarity of the temperature at the commencement of picking in all countries except Mesopotamia. But the phenomena in the Sudan concern the early stages of growth. If his diagrams be studied,* it will be noticed that three countries exhibit an excessive temperature at this

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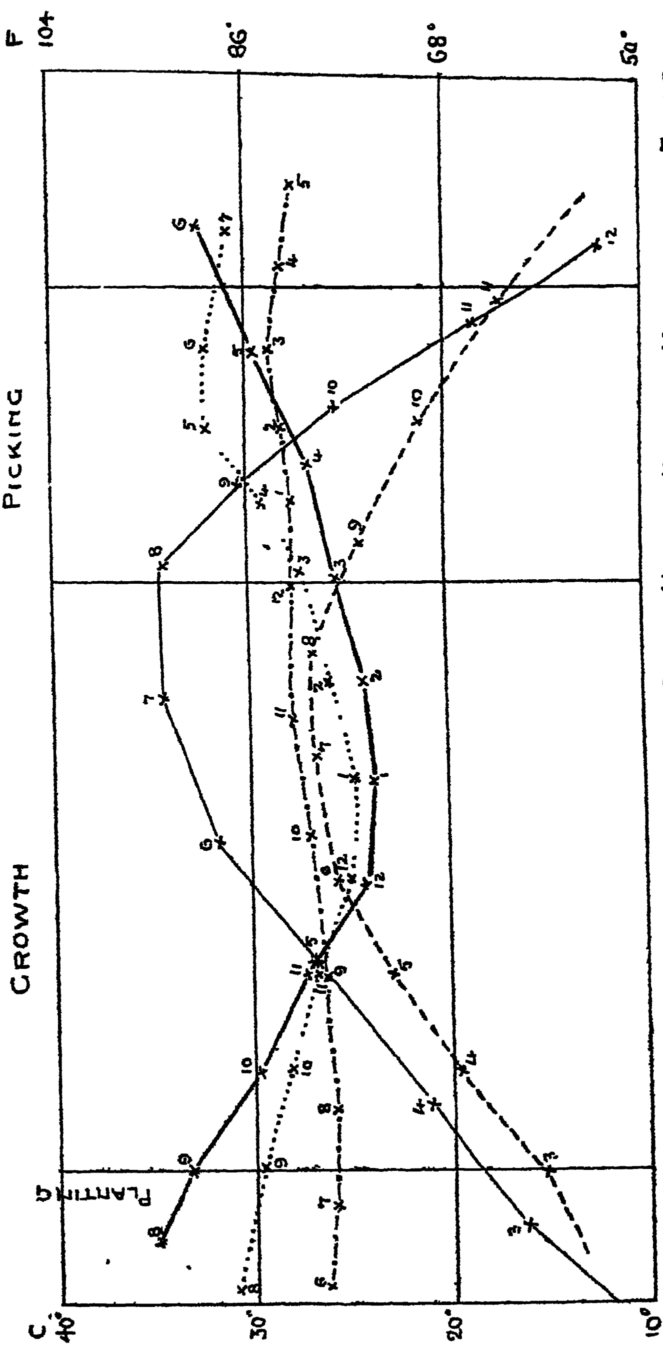
* The diagram appended is taken from this paper.

DIAGRAM



Mean Temperature during Cotton Season in Sudan, Madras, Nigeria, Mesopotamia, Egypt

▬ Sudan, ........ Madras, —·—·— Nigeria, —— Mesopotamia — — — Egypt

Points marked X with a number indicate the month of the year

(From Williams)

period: the Sudan, with an average mean temperature of 29° C. to 31° C.; Madras, with an average mean temperature of 28° C. to 29° C.; and Nigeria, with an average mean temperature of 27° C. to 28° C. The remaining countries have average mean temperatures ranging from 12° C. to 21° C. Of these three countries the Sudan only has a markedly low air humidity, and it is an obvious temptation to look to these two abnormal conditions, high temperature and low humidity, for an explanation of the abnormal development of the plant.

The problem in the Sudan is here referred to because it illustrates, better than any other known to the writer, the intricacy of all problems concerning the water balance of plants in the field. What the true explanation may be, and whether there be any basis for the speculations here outlined, for on the available information they cannot be other than speculations, will only be determined by the work now in hand in the Sudan.

It would appear, then, that in the tropics, while humidity is the major factor controlling the growth of the plant, that control is exercised in two entirely distinct ways; through the soil, as soil moisture, and through the air as air humidity. The former phenomenon is regularly exhibited, and, since the fluctuations in soil moisture are relatively slow, considerable progress has been made in the determination of their effect on the growth of the crop. Fluctuations in air humidity are much more erratic and rapid in their incidence. Not only is there frequently a large daily fluctuation, but those changes are intimately bound up with other conditions such as insolation and temperature, and the effect of air humidity as distinct from these others is not readily determined. The plant itself, too, possesses a greater capacity to adjust itself to these rapid fluctuations. The writer well remembers the first introduction of the Natal-Java indigo plant into Bihar early in the century. Seed was obtained from both countries, and though specifically the same plant, there was a marked varietal difference between the plants according to their source. Seed is harvested by cutting the plant and laying it out to dry, and, on drying, the pod is explosive and capable of throwing the seed some yards. In one case the plants of the two varieties had been cut and laid out to dry in close proximity, with the result that the seed became inextricably mixed and the subsequent crop was likewise mixed. It was possible, however, merely by standing beside a field during the hot part of the day, to pick out the two varieties with certainty; for one (memory does not at this distance of time carry with any certainty which one) was distinctly more delicate, and in it the leaflets had closed on to each other and the whole leaves were folded round the stem, while the hardier variety did not require to make use of this adaptation against excessive insolation and low air humidity. The water balance of crops under arid conditions and irrigation thus offers problems of a complexity greater than is the case in a rains tract.

*Received May,* 1928.

### ADDENDUM.

The original paper has just appeared in *Proc. Roy. Soc.*, B, **103**, 1928, p. 82.

# COTTON IN THE PUNJAB

BY

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A SCIENTIFIC direction of the process of agricultural improvement is admitted to be, in these days, a *sine qua non,* and its value has been proved time after time. Rarely, however, has a more striking example been provided than in the Punjab. The history of American cotton-growing in the Punjab shows what can be accomplished, and also, at the same time, holds out prospects of still further improvement in the future.

It is many years since American cotton was first tried in the province. The introduction came from Dharwar. American cotton, of what was known as the New Orleans type, was introduced there in about 1825. Small samples of seed were brought for trial into the Punjab from time to time, but the crop failed to make headway. The farmers probably found that under the rainfall system of farming enough water was not always available to ensure the crop maturing, and a return was made to the indigenous or desi type, which was hardier, and even in bad years would give something of a crop. Here and there fields of American cotton were still grown; and among the plants in the desi crop solitary American plants survived. This was the *narma* cotton of the Punjab.

Hence, when the Agricultural Department began serious work on cotton in 1903, there was ready to hand a type of American cotton which had been growing in the province for years. In addition, fresh importations of Dharwar American seed were made. The ample supply of water consequent on the building of the new canals seemed to indicate that, for the irrigated districts, the main obstacle to the growth of American cotton on a large scale had now been removed. Mr. Milne, who was appointed in 1907, started by adopting both the *narma* and the Dharwar American types—in addition to other imported varieties—as the basis of his selections.

His first selection to be grown on a large scale was called 4F. This was handed over to the Agricultural Department in 1913. In 1924 this cotton was grown on an area of over a million acres, and in 1927, in spite of a failure year in 1926, combined with very low prices, the area was over 730,000 acres.

Further selections were evolved which in some respects were improvements on the 4F variety, but the ordinary Indian cultivator or zemindar has, so far, failed to adopt these with any enthusiasm. These selections, of which the two best known are 285F and 289F, though much better in staple, required from the average zemindar a much higher standard of care than he had been accustomed to give his 4F, and in consequence were never widely adopted. 289F with good cultivation can give high profits, as has been shown on the B.C.G.A. farm at Khanewal, but, being rather later in maturing than 4F, there was a certain element of insecurity about it in a locality where early frost might be expected. 285F has almost completely gone out of cultivation in the Punjab, though it is still popular in Sind. The reason generally given for its unpopularity was that it was not so hardy as 4F. The table below shows the respective areas of these varieties in 1926.

| *Variety.* | *Area in Acres in* 1926. |
|---|---|
| 4F | 1,126,587. |
| 285F | 6,112. |
| 289F | 5,500 (approx.). |

There are many desi varieties grown in the Punjab. Their common characteristic, compared with the cottons grown in the more southern parts of India, such as Surat or Madras, is a shorter growth period. This is necessary, as the cold weather in the Punjab starts early and may be cold enough to check all further development of the plant. In the south of India the cottons flower through the so-called cold weather, and picking does not begin until the beginning of February.

The following table shows the predominating types of desi cotton in different districts* of the province. In no district are these types grown absolutely pure by the zemindar unless the seed has been obtained from the Agricultural Department.

| *District.* | *Predominating Type Grown.* |
|---|---|
| West Multan | *G. sanguineum.* |
| East Multan | *G. indicum* (yellow-flowered). |
| Jhang | *G. indicum* (yellow-flowered). |
| Shahpur | *G. indicum*, with *G. sanguineum* next. |
| Gujranwala | *G. indicum*, with *G. sanguineum* next. |
| Sialkote | *G. indicum* (yellow-flowered). |
| Rohtak | *G. neglectum* (yellow-flowered), with *G. indicum* next. |
| Ludhiana | *G. neglectum Var rosea* (white-flowered) with *G. neglectum* (yellow-flowered) next. |

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* Full details are available in the cotton surveys of these districts, published by the Punjab Government (Government Printing Press, Lahore). The nomenclature is that used in these reports.

In addition, *G. cernuum* and *G. herbaceum* are occasionally found as constituents of the mixture. Odd fields of pure *G. herbaceum* have been recorded, but the seed in some such cases has proved to have been imported from outside the province.

The most popular improved variety is a white-flowered *G. indicum*, to which the varietal name of *Mollisoni* has been given.

The general line of progress in desi cottons has been in the direction of an improvement in the ginning out-turn, rather than in the direction of improvement in the length of staple. The staple length of desi cotton is not of great importance to the purchaser, whereas higher prices are obtained from the ginner for a cotton with a high out-turn. Hence the popularity of high out-turn cottons with the zemindar. It is of interest to note that improvement on these lines is paralleled in other provinces—for example, the United Provinces and the Central Provinces, though in these provinces the actual variety is different.

*4F and* 289*F*.—4F is a plant with a spherical outline, bushy in appearance, about 1 metre to 130 cms. in height. The monopodia are numerous, as many as twenty or more occurring on one plant. The stems and branches are densely pilose, and become markedly sunburnt as they age. The sympodia are borne at the extremities of the stem and monopodia. The early sympodia on the main stem either never develop, or are aborted at an early stage. They never produce fruit. The fruit-producing sympodia may bear as many as three or four bolls per sympodium.

The flowers are of the normal American type, ivory-coloured, and without leaf spot. The pollen is whitish.

The leaves are small to medium in size, five-lobed, with a not very prominent pulvinus spot. They are not deeply incised, and the sinus is only moderately plicate. The lobes are mediumly inflexed. The upper surface of the leaf is not so hairy as the under surface.

The boll is almost spherical in shape, and generally four-locked. The lint and seed characters are shown in the table below, where 4F and 289F are compared.

289F is a cotton with a similar habit of growth to that of 4F, and only a few differences in other respects.

The 289F plant is a larger and even bushier plant than 4F as a rule, with larger and flatter leaves; its leaves are not quite so hairy, and it takes considerably longer in its vegetative growth. The main differences lie in the lint and seed, as shown in the table on p. 231.

### LINT AND SEED CHARACTERS OF 4F AND 289F.

AVERAGES OF 300 BOLLS COLLECTED AT RANDOM IN 1905 AT LYALLPUR.

| | *4F.* | *289F.* |
|---|---|---|
| Number of locks per boll. | Over 98 per cent. four-lock. | Two-thirds four-lock, one-third five-lock. |
| Weight of seed cotton per lock. | 0·87 grm. | 0·88 grm. |
| Weight of lint per lock. | 0·286 grm. | 0·256 grm. |
| Weight of 100 seeds. | 8·0 grms. | 9·2 grms. |
| Lint index (weight of lint per 100 seeds). | 3·9 grms. | 3·76 grms. |
| Ginning out-turn. | 33 per cent. | 27 per cent. |
| Average combed halo length. | 22·0 mms. | 28·7 mms. |
| Seed characters. | Greenish fuzz, very variable, from almost naked to full fuzzy. | White full fuzzy. |

*Climate of the Punjab.*—Cotton is grown in the Punjab during the summer. Sowing takes place from the end of April to the beginning of June. Both May and June are dry and very hot. The temperatures are more severe in the south-western portion of the province than further north and east. A fall in temperature occurs at the beginning of the rainy period. The rains occur in spasmodic showers from about the middle of July until the middle of September. The lines of equal rainfall run approximately north-west to south-east, and the south-western portion of the province gets the least rainfall. The conditions for growth during this period are generally favourable, though there is a tendency for the cotton plants to make too much wood. A characteristic feature of the summer are the frequent dust storms. These have a markedly depressant effect on the growth of the cotton plant, and may do considerable damage during the early stages.

*General Methods of Cultivation.*—In irrigated tracts cotton is sown after toria (*Brassica campestris*) or wheat. The beginning of May is usually accepted as the best time for sowing, but there is recently a marked tendency for sowings to become later. This is possibly correlated with the practice of sowing after wheat.

Generally the land is irrigated, and as soon as it can be worked it is ploughed, sohagaed,* and the seed either scattered broadcast and harrowed in, or sown in the furrow of the desi plough in lines.

The more enlightened cultivator tries to avoid sowing cotton after wheat, but as the area of wheat is generally about half the holding, it is frequently difficult to avoid doing so.

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* The sohaga is a heavy beam drawn over the land by bullocks, which acts as a clod crusher and also compacts the soil.

Cultivations prior to the sowing of the crop are occasionally given, but if cotton is sown after wheat there is actually no time for them, as the wheat is generally not harvested sufficiently early to allow of more than an immediate watering, and sowing on the seed bed produced from this.

As the temperatures are high, germination is rapid, and the seedlings are through in four to five days. The average seed rate is 9 to 10 lbs. per acre.

From now until the end of June water is withheld unless the crop shows serious signs of distress. From that time five or six irrigations are given up till the end of September. The Agricultural Department, however, recommends that irrigations should be given in October and November. The average cultivator does not take very kindly to this, as his main interest seems to lie in the wheat crop, and water is required at that time for preparing the land for wheat. As toria sowings are also made in September, if possible, the demands on the available water-supply are very great, and the cotton suffers.

The practice of sowing in lines is making headway, and this permits of inter-tillage. But still many cultivators do no tillage work on the crop at all from sowing till picking.

Picking starts about the beginning of October, and if conditions are favourable may continue till January. The first pickings are not so good as the later pickings from the point of view of lint quality or seed development.

The first flush of flowers arrives at the beginning of August, and the first bolls open at the beginning of October. Few flowers are formed on the main stem. It seems that the air shade temperatures and the soil temperatures during May and June are so high that the plant is not given an opportunity to develop the sympodial branches that would be expected on the main stem, and so produces its crop on the monopodial branches. This would account for the fact that three months elapse after sowing before the flowering flush, instead of just over two months, as appears to be usual with other American cottons.

The time of maturation from the flower to the boll is with 4F about thirty-five to forty days, which lengthens as the season progresses. Yet there is a period of about nine weeks from the commencement of flowering to the commencement of bolling. This delay requires some explanation, and the cause of it may be found in an observation that has been made both in 1926 and 1927, that in the early flowers there is a very considerable degree of non-dehiscence of the anthers in what appear to be otherwise perfectly normal flowers. In consequence of this, fertilization does not take place, and there is a complete shedding of the first formed bolls at a very young stage. This phenomenon is being investigated, and details will be published in due course.

Flowering, when it starts, is very prolific, but the shedding of bolls, even after the time when anther dehiscence is normal, is so heavy that the crop obtained never fulfils the promise of its flowering. The percentage of bolls set from flowers opened is as low as 20 per cent. to 30 per cent. only.

A difficulty which besets the cultivation of American cotton in the Punjab is the occurrence sporadically of " failure years " when, after a good start and apparently every indication of a good crop, just at the time the early bolls commence to open it is found that the lint is weak and the seed ill-developed, with the result that the bolls do not open properly and poor yields are obtained. In a " failure year " this " bad opening " affects large tracts of country.

The symptoms of this failure are similar to those recorded for " rust " or " potash hunger " in America. In that country the failure to make a crop is attributed to some form of soil deficiency. Whether a similar explanation would serve to explain the Punjab failures is somewhat doubtful, though it seems to be generally considered that the soils of the Punjab tend to be deficient in humus. There seems to be little doubt that there is some nutritional defect which affects the plant, but more work is required from different aspects of the problem before certainty can be attained. The work done so far shows that the plant grows under very severe climatic conditions, and that dust storms, low humidity, high air and soil temperatures exercise a depressant effect on growth at a time when shoot and, particularly, root growth should be proceeding without check. These preliminary checks would render the plant less resistant to any adverse conditions which occurred later. Thus in " failure years " it may happen that during September there may be severe dust storms or low humidity, which, acting on a plant already affected by an untoward environment earlier in the year, may complete the crop's destruction.

The most hopeful prospect of a total elimination of this difficulty lies in the provision of a plant which, with more careful cultivation (to ameliorate the stringency of the climate), will be able to withstand the most unfavourable environment which might occur. That this may be a difficult matter will readily be realized. 4F cotton itself is a particularly hardy cotton. Evidence of this was found in the behaviour of Mesowhite cotton, which was found to be a cotton suitable for the very severe climate of Iraq, but which at Lyallpur in 1927 showed many of the same symptoms that 4F exhibits in a "failure year." The year 1927 was a partial "failure year," but the cotton was not so badly affected at Lyallpur as in other parts of the province.

It will be seen, then, that the general improvement of the Punjab American crop depends on (1) the provision of a still hardier variety, (2) further research into the best methods of growing the crop, and (3) the adoption by the zemindar of these methods when and as they are evolved. Much has been done, but much still remains to be done.

### WORK IN PROGRESS,

*Pure Line Work.*—In pure line work with the American types the main characters aimed at, apart from heavy yielding capacity, are:

(1) A length of lint 1⅛ inches or over; (2) a high ginning out-turn. Any type must be hairy, as there is otherwise the risk of jassid attack.

Subsidiary to these, a naked seed is preferable to a full fuzz, as the custom of the zemindar is to feed his cattle with cotton seed when available. For this purpose a naked-seeded cotton is preferred. Naked seed would, however, be of minor importance, in comparison with the essentials mentioned above.

A cotton which will produce its crop earlier than either 4F or 289F is also desirable. Apart from the possibility of using the land more intensively if the zemindar could pull his cotton sticks in November instead of February, the overwintering of insect pests would be checked. On the other hand, an abnormally early crop is probably not universally desirable, as the quality of the cotton might be spoilt by late rains. A cotton early enough to permit of wheat being sown after the cotton was removed—as is the common Egyptian practice —,would involve a considerable change in the irrigation practice.

An "early" strain has recently been produced from an original selection in 1925, which promises well. It has lint of a satisfactory length and a fairly high ginning out-turn. The variability of the 4F seed for amount of fuzz proves to be due to a mixture of different pure lines, and families breeding true for full fuzz character and for almost naked seed have been separated out.

About 100 American and 100 desi pure line families are grown annually on the experimental farm.

*Growth, Flowering, and Bolling Records.*—" Plant development " curves are maintained and compared with climatic data. The course of daily growth is inversely correlated with maximum soil temperatures at 30 cms. depth; when the temperature of the soil at this depth reaches about 30° C. there is a depressant effect on growth. The soil thermograph records show that the soil temperature may be above 36° C. for hours daily during June, and occasionally the minimum temperature is above 36° C. for two or three days.

Minimum air temperatures show some, but not a marked, effect on elongation; and days of high evaporation—which are frequently days on which dust storms occur—also show some depressant effect on growth. Dust storms, which are of frequent occurrence, cause a marked effect in reducing the amount of growth. Apart from temperature effects, it appears that there may be a definite physical effect, arising from sand and dust particles being blown against the plants by the high wind.

*Flowering Records* show little relation to the growth curves. As most of the flowers which open are borne on the monopodial branches, it is not surprising that growth of the main stem and flowering are uncorrelated. The daily fluctuations, however, agree closely among themselves in curves from different varieties and treatments, so the probability is that the rate of the flowering depends on some external environmental factor.

In Egypt it has been shown that shedding of flower buds probably determines the fluctuations of the flowering curve, and data bearing on this point are being collected for Punjab American cottons. On account of the habit of the plant and also that, as shown by the 1926 and 1927 records, the total amount of bud shedding varies very considerably from year to year, the demonstration of the effect may be difficult.

The period of development of the flower from the first external appearance of the bud in the axil of the expanding leaf is thirty-three days, a period similar to that found in Egypt.

*Bolling Records* so far have given very little satisfactory information. The percentage of shedding of the young bolls is very high—between 70 per cent. and 80 per cent.—and any relationship between flowering and bolling is very vague.

The young bolls are shed at an average age of three to four days, and the period of maturation of the boll from the flower varies from thirty-five to forty days in the early part of the season, to over fifty days at the end of the season.

A thirty-five day period of maturation appears to be very short, compared with the maturation period of bolls of other varieties in other countries. As noted earlier, a recognized characteristic of the first pickings of Punjab American cotton is that they contain a noticeable proportion of weak and undeveloped fibre. This gives ground for the suspicion that the short maturation period is actually insufficient to mature the lint and seed properly. In view of what has been said above about the high soil temperatures which prevail in the Punjab, support for this suspicion is obtained from work in Egypt, where high soil temperatures were suggested as the reason for the shorter boll maturation period of plants grown in boxes. High soil temperatures in America have been shown to affect root development adversely. An insufficient root development implies an insufficient supply of nutrient material to the plant, and it seems possible that this may be the originating cause of the shortened maturation period. There are other observations which also point to this being the underlying cause of ill-developed seed and lint in the boll.

*Climatic and Meteorological Records.*—Full records are kept of as many environmental conditions as possible which are likely to affect the crop. In addition to air temperature, rainfall and humidity records, records of soil temperatures, evaporation, sunshine, black and bright bulb, and also daily weather notes are maintained. These will become very valuable as they accumulate.

*Roguing of Commercial Varieties.*—In addition to pure line work, roguing of bulk plots of commercial varieties is undertaken. The Department of Agriculture is able to call on certain large estates under the terms of their leases with Government for the growing of considerable areas of any variety which it is desired to propagate. On certain of these estates an area is set aside for roguing. The seed from this area provides seed for a larger area on the estate the following year, and a small area is again taken from this previously rogued seed for further roguing. The purity of the cotton is maintained or even improved by this process, and the Department is able to control for distribution a considerable bulk of seed of a high percentage purity.

*Comparative Trials.*—Large-scale variety tests and a watering test are carried out. New types are tested against the standard commercial types, and different types of watering and cultural conditions are tested against the standard. The Differential Watering test has only been in hand for one year, but in that year interesting indications were obtained. The quantities of water applied were measured by means of a notch weir in the field channel. The accuracy of this form of measurement is vitiated by one or two minor factors, but these were partly overcome by taking the readings of the levels at the weir every five minutes while the water was flowing and averaging for the period of flow. It was found that the more water that was given during the season the greater the yield; and that for an equal number of waterings given to cotton grown on ridges (in the Egyptian fashion) a greater yield is obtained by the use of about 80 per cent. of the amount of water given in an equal number of waterings on the flat. Work in America on the root growth of the cotton plant as affected by flooding of the soil (combined with soil temperature), and Dr. Harland's suggestion that faulty irrigation may be the cause of the high proportion of weak hairs found by Miss Clegg in Punjab American cotton, show the importance of detailed work on the water requirements of cotton in the province.

*Insect Pests.*—The pink bollworm and the two Earias bollworms (*E. insulana* and *E. fabia*) are the most serious insect pests. The former is particularly bad in the south-east of the province where desi cottons are chiefly grown. It is to be found, however, on American cotton in the Canal colonies, but whether it is likely to become a serious pest there or not is not yet determined. Although it has been present for some years, it does not seem to have increased appreciably. The Indian Central Cotton Committee have subsidized a scheme of research which is directed to discovering the reason for this; at present the opinion generally expressed is that the climate of these parts has a deterrent effect on the pest, but, in view of how serious it might become, this opinion requires experimental proof.

Earias years occur occasionally, when very considerable damage can be done, but normally the Earias bollworms are not thought serious.

Jassid (*Empoascus*) is present, but, on account of the hairy character of 4F, generally fails to do any noticeable damage.

A "white fly" (*Aleurodes*) is constantly to be found during the humid months of July and August, sometimes in enormous numbers. It is reputed to do damage by the zemindar, but so far an accurate estimate of its harmful capabilities has not been experimentally determined. Attacks of "white fly" are frequently reported under the term "aphis."

The ordinary cutworm can be found on the seedling stage, and a species of thrips attacks the young plant in the early stages. A stem borer (*Sphenoptera*) is also found occasionally.

When the bolls are open, the cotton seed bug (*Oxycarenus* sp.) congregates in them in thousands, and a red stainer bug (*Dysdercus* *cingulatus*) is supposed to damage the seeds every year by sucking the seed juices.

*Marketing.*—There are two principal methods by which the zemindar can dispose of his kapas (seed cotton). He may sell locally to the village shopkeeper, who generally gives a poor price, but the zemindar is saved the trouble of carting his kapas to the local market (mandi), which may be fifteen or twenty miles distant. Or he may, as frequently happens, bring the kapas to the market and sell it direct to a broker or to a ginnery. There are many opportunities for sharp practice, and the illiterate small farmer probably does not get a fair price even then, though it may be better than he would get in the village.

The Indian Central Cotton Committee are assisting financially in an investigation which is now being carried out by the Punjab Government into cotton marketing; the result when published should be of the greatest interest, and may give an opportunity for standardizing the market practices at the different mandis.

The kapas, when bought by the ginner, is stored in the open in the ginnery yard awaiting ginning, baling, and export. The American cotton as grown in the field is generally of high purity—fields with a mixture of more than 5 per cent. of desi plants are in the minority. Mixing of desi and American kapas takes place in the ginnery, and the resultant lint finds a ready sale, particularly to Japanese spinners; but such mixing naturally reduces the value of the lint for Lancashire's purposes. Mixed Punjab American is also penalized in Bombay. In spite of this, prevention of mixing seems difficult; at present the lint is not graded for staple length, but only for " class "; if, or when, grading for staple becomes general, on account, say, of the wider cultivation of an American cotton of the 289F class, with a staple of 1⅛ inch or over, there may be a possibility that mixing will decrease.

*Received May,* 1928.

# THE TREATMENT OF COTTON SEED BY SULPHURIC ACID

From the published literature on the treatment of cotton seed, before planting, with sulphuric acid, it appeared that a number of questions were involved, including the effect on germination, the sterilizing effect, the concentration of the acid used, and the period of immersion.

A doubt had in particular been expressed as to whether the treatment might not impair the germinating power of certain varieties, or of seed which had already been somewhat affected by parasites.

At the request of the Corporation, the Physiological Department of the Imperial College of Science and Technology kindly undertook to investigate the treatment, and the report received from Professor V. H. Blackman, F.R.S., is now published. It is hoped that the conclusions reached will be reassuring to those who use this process of seed treatment in different cotton-growing countries.

For the purpose of the investigation the Corporation's officers in the Sudan, Australia, South Africa, Rhodesia, Nigeria, and Nyasaland were asked to forward representative samples of seed, including (*a*) the different varieties or strains that were being grown; (*b*) where available, seed from plants grown at different elevations, and in varying rainfall; (*c*) seed from plants that had been subject to little or no damage from insect pests and diseases; (*d*) seed from plants that had shown such damage.

In cases where the lint had been stained owing to the attacks of insects or of disease, officers were asked to include also a small sample to indicate the degree of staining.

Finally, where officers had facilities for carrying out experimental work, they were asked to send detailed descriptions of the procedure ordinarily followed by them when treating seed in this way, accompanied by recorded observations of the rise in temperature which occurs in the course of the treatment. They were further asked to determine, where facilities existed, the water content of the seed before treatment.

The following report is based on the results obtained by Professor Blackman and his staff in the light of the information on the above points kindly supplied by the Corporation's officers overseas, whose assistance and co-operation are hereby gratefully acknowledged.

# REPORT ON THE SULPHURIC ACID TREATMENT OF COTTON SEED

By PROFESSOR V. H. BLACKMAN, F.R.S.

The value of this treatment for surface sterilization of the seed has already been demonstrated, but there seemed some possibility that the seed might, in some cases at least, be damaged by the treatment, and the germinating power thus reduced. The germinating power of seeds soaked in concentrated and in dilute acid has therefore been compared with that of controls soaked in water only. The results are based on the examination of 11,000 seeds.

Treatment with Strong Acid.—In these tests twenty samples of different origin, with germinating power varying from 5 to 100 per cent., have been tested by soaking for twenty to thirty minutes in concentrated acid in sufficient quantity to cover the seeds, and then washing in several changes of water for another twenty minutes.

The controls were treated for forty minutes in water only, and the control and experimental sets then germinated under the same conditions at 26° C. The percentage germination was taken at the second, fourth, and sixth day.

A study of the percentage germination in the different cases showed that in some cases the control seeds gave the higher germinating power, and in other cases the acid-treated ones. There was no clear evidence of definite increase or decrease in germinating capacity as a result of the treatment, whether one is dealing with seed showing good germination or seed of a germinating capacity of only a few per cent. It is possible that in some few cases the acid may produce a slightly favourable effect on germination under these conditions, but it must be a very slight one. There is no evidence of any injurious action.

An epitome of the results with strong acid is given below. It is to be noted that the germination in both cases is as complete after four days as after six days. With the acid treatment, however, there is earlier germination, the second day results being in both sets of samples higher after acid treatment.

Germinating Capacity of Seeds treated with Concentrated Sulphuric Acid.

| | *Concentrated* $H_2SO_4$ 20-30 *Mins. Washed*, 20 *Mins.* | | | *Water*, 40 *Mins.* | | |
|---|---|---|---|---|---|---|
| Number of days in incubator (26° C.) .. .. .. | 2 | 4 | 6 | 2 | 4 | 6 |
| Average of 20 samples with germinating capacity above 50 per cent. .. .. | *Per Cent.*<br>67 | *Per Cent*<br>79 | *Per Cent.*<br>80 | *Per Cent.*<br>42 | *Per Cent.*<br>77 | *Per Cent.*<br>78 |
| Average of 17 samples with germinating capacity below 50 per cent. .. .. | 17 | 23 | 24 | 9 | 24 | 24 |

Effect of Weak Acid.—The use of dilute acid has recently been recommended by Sherbakoff in place of the concentrated acid. In this method the seeds are thoroughly wetted with the weak acid and then allowed to dry, thus concentrating the acid remaining on the surface of the seed. In our experience this method did not delint the seeds and produced a very serious reduction in their germinating capacity.

Temperature Effect.—It seemed possible that if treatment with strong acid had any detrimental effect on the viability of the seeds it might be due to the rise of temperature associated with the treatment. The temperature change, when the acid comes in contact with the small amount of water in the seed coat, is only slight, as our observations show. This is confirmed by the reports to the Corporation of those who have used the treatment under field conditions. If, however, during the process of washing the mass of seeds is not well stirred, local heating of individual seeds may occur as a result of combination of water with acid absorbed by the seed.

Conclusion. — Treatment of cotton seed with concentrated sulphuric acid for twenty to thirty minutes, followed by washing in several changes of water for twenty minutes, can be safely used for delinting (by which an earlier and more regular germination can be obtained in the field), and for surface sterilization of the seed. The viability of the seed, as measured by germinating capacity, remains unimpaired, whether one is dealing with a good sample of seed or a poor one in which the germination is as low as 5 or 10 per cent.

Addendum.—Some further experiments were undertaken in which the seeds were exposed for longer periods to the concentrated acid the after-treatment being the same.

The results are given below.

| | *Germination (per Cent.).* | | |
|---|---|---|---|
| | *Two Days.* | *Four Days.* | *Six Days.* |
| Water (40 minutes) .. .. .. | 68 | 86 | 86 |
| Concentrated $H_2SO_4$ (½ hour) .. | 85 | 92 | 92 |
| „ „ (1 hour) .. | 71 | 86 | 86 |
| „ „ (2 hours) .. | 91 | 93 | 93 |
| „ „ (4 hours) .. | 88 | 96 | 96 |
| „ „ (6 hours) .. | 78 | 92 | 92 |

An exposure to the strong acid for so long a period as six hours has thus no injurious effect on the sample tested. Complete delinting was attained in four hours.

I have to thank Mr. B. D. Bolas, who has carried out the germination tests.

# THE IMPROVEMENT OF UPPERS

BY

C. H. BROWN, B.Sc.,

*Botanical Section, Ministry of Agriculture, Egypt.*

IN the latter part of the last century the standard cotton of the whole of Egypt was a variety known as Ashmuni. Towards the end of the century came a succession of new varieties, each to some extent an improvement on the preceding ones, culminating in the introduction of Sakel in 1910. The student of the history of cotton varieties in Egypt will notice that these new varieties were exclusively cottons for the Delta. With the coming of the first of them, Afifi, in 1882, the old Ashmuni cotton was relegated to Upper Egypt, and distinguished from the new Delta cottons by the name Uppers. The varietal name Ashmuni has persisted in Upper Egypt from that day until now, although whether the typical Uppers of the present day is in all respects the same as that of forty years ago cannot be determined with certainty. Only a series of spinning test records, length, and fineness measurements, such as did not then exist, could enable us to say accurately, but it may safely be assumed that the type has changed somewhat, mainly owing to leakage of Upper into Lower Egypt and Lower into Upper Egypt.

The student will now ask why there has been such a marked improvement of Delta cottons by introduction of new varieties, as compared with the small shift in Uppers. This question is exceedingly difficult to answer. The only obvious reason that instantly suggests itself is the concentration of the interest in cotton quality in the Delta, due to its greater proximity to the grading centre of Alexandria and the ginning centres of Kafr-el-Zayat and Mahallet Kebir. The introduction of new varieties can only be effected by definite selection and seed control in the early stages, coupled with advice on their quality and value by those competent to judge, by enlisting the early interest of the exporting merchants, presuming that the financial advantage to the grower has been proved. All these in the past have obviously been easier to secure in the Delta, and this alone may have been sufficient to account for the rapidity with which new varieties have been introduced from the early years of the century until now. Many of these were of no permanent value, or if good were introduced in an impure state and quickly died out; a few, the most notable being Afifi, Abbassi, Yannovitch, Assili, and Sakel, were a definite improvement on existing cottons, and held the field for a time.

No such widespread interest in new varieties has been seen at all in Upper Egypt; indeed, it is generally tacitly assumed, and occasionally definitely stated, that good quality cottons cannot be grown south of Cairo. The statement has this much of truth in it—that the present-day Delta cottons will not grow well in Upper Egypt. But this is obviously begging the question. The Delta varieties of today are all presumably suited to Delta conditions, with their lower temperatures, greater humidity, and higher proportion of salt in the soils, and therefore could not be expected to be equally suited to Upper Egypt. It is becoming increasingly realized by plant breeders that all suggested new varieties must be studied in relation to the particular district in which it is required to grow them, the obvious corollary to this being that in an attempt to improve the crop of any district, both the original selection and the growth and testing of the selections should be made in the district itself. Very little of such work has ever been done in Upper Egypt.

The only exception of note to this statement was provided by the variety Zagora, which was introduced into Upper Egypt by M. Parochimonas, but quickly lost its identity there, becoming hopelessly merged in Ashmuni, the two together still being known to the trade as Uppers. As a variety for the south of the Delta, Zagora preserved its identity for a few years longer.

With the formation of the Cotton Research Board in 1920, for the first time facilities became available for selection work on Uppers being carried out with the same ease as for Delta cottons, and the results of the work so far have already gone a long way to disprove the idea that Uppers cannot be improved.

Two bulk selections—one from Ashmuni and one from Zagora, which were in the hands of the Ministry of Agriculture at the time of the formation of the Cotton Research Board—were first subjected to experiment. The Ashmuni selection quickly showed itself to be a particularly prolific yielder, and was first launched out into bulk propagation under the name of Ashmuni Malaki (Royal Ashmuni).

As has been mentioned, the outstanding quality of this variety was its high yield. Reliable comparisons of its quality with that of the Ashmuni it replaced are difficult. The only figures available are those left by Mr. Bailey, late Botanist to the Ministry of Agriculture, stating the characteristics of the main Egyptian varieties as he found them when he arrived in Egypt in 1919. He then stated that the average combed halo-length of Ashmuni was 25-26 mms. Ashmuni Malaki now gives combed haloes of 27-29 mms., so is presumably an improvement on the old Ashmuni—at least in length. No comparative spinning test or fineness measurements are available, and a comparison with present-day mixed Ashmuni would be valueless, as this in practically all cases would by now be a descendant of seed originally taken from the Ministry.

Direct comparisons are, however, available from Ashmuni Malaki to the newer introductions. It was soon realized that the Zagora selection was as valuable agriculturally as Ashmuni Malaki, and, in addition, it was found to be a better spinning cotton. In 1926 the decision was taken to substitute this for Ashmuni Malaki, under the name of Zagora Malaki. Bulk propagation of this type has therefore been pushed ahead, and distribution of Ashmuni Malaki will cease with the current year (1928). Figures in the possession of the Cotton Research Board show the Zagora to have made a yarn at 80's averaging 10 per cent. stronger than the yarn from the Ashmuni Malaki. The reason for this increased yarn strength may be sought in the measurements of the fibre made in the laboratory. In a series of localities in 1927, Zagora Malaki has given a halo-length 1 mm. longer than Ashmuni Malaki—*i.e.*, 28-30 mms. (shorter haloes are generally obtained from the same variety grown further south)—and measurements of the hair diameter taken from green bolls have shown it to be very slightly finer.

The improvement of Uppers has thus started. The prospect of further improvement lies in the wide-scale propagation of the varieties at present in the hands of the Cotton Research Board, which still further belie the adage that fine cottons will not grow in Upper Egypt. Many selections, some of them with lint lengths equal to that of Sakel, are under trial, but how far these will prove agriculturally valuable to the fellah is not yet known. Two selections, however, have already given such good results that wide-scale propagation of them has been commenced in the present season.

The first of these, Giza 2, has now been named Ashmuni Gedeed (new), and is planted in 1928 on an area of about 1,500 acres. The qualities of this variety are such that it may be safely predicted that in two or three years Zagora Malaki will have been completely replaced by it. Figures available show another millimetre in halo-length—*i.e.*, 2 mms. longer than Ashmuni Malaki, a 4 per cent. reduction in hair diameter on Zagora Malaki, or 5 per cent. if compared with Ashmuni Malaki, and a yarn strength at 80's of 1-3 per cent. more than Zagora Malaki. Some figures for spinning at lower counts—*i.e.*, more usual Uppers counts—have shown its yarn strength to be even more superior to Zagora Malaki. All this indicates a slightly better quality. Ashmuni Gedeed couples with this a definite agricultural superiority over Ashmuni and Zagora Malaki (which were for all practical purposes agriculturally identical), having given as an average in several localities in two seasons a 3 per cent. better yield, and having proved slightly earlier in flowering and bolling.

Another step has thus been taken, for it may safely be stated that no cotton as good as Giza 2 has before been available from Upper Egypt. The next step in sight, albeit a slightly more problematical one, is the propagation of another new selection called Giza 3. All Uppers types so far, including Giza 2, have been practically identical in the field, at least sufficiently so to be included in one recognizable agricultural type. Giza 3 is a new departure. Its taller habit of growth, darker coloured leaves, red stems, and lighter flowers, all render it easily distinguishable from ordinary Uppers. It is also distinctly later in growth and flowering, and this is, indeed, its only obvious drawback. It remains to be seen whether its good qualities outweigh this. At present they give every indication of doing so, particularly in the southern districts of Upper Egypt. A cotton like Giza 3 that will grow in Upper Egypt and not lose in yield should have a marvellous future, and may, in fact, comparatively soon replace entirely the old Uppers. Upper Egypt being practically free from bollworm, slight lateness is no great disadvantage. It also appears to resist severe dry weather or soil conditions.

The lint of Giza 3 may be considered to be out of the Uppers class. In combed halo-length and hair-diameter figures equidistant between those of Zagora Malaki and Sakel are obtained—*e.g.*, with Zagora giving a halo of 30 and Sakel 36, Giza 3 gives 33. In yarn strength Giza 3 has given figures of from 10-20 per cent. stronger than Zagora at 80's. In direct comparisons with Pilion, a cotton grown exclusively in the Delta, Giza 3 has been considered to be superior.

It would seem likely that these two varieties—*e.g.*, Giza 2 and 3—will presently come into open competition in Upper Egypt for the best to win. The premium which spinners are prepared to pay for Giza 3 may decide the issue. The replacement of the large Zagora areas at present grown in the south of the Delta by Giza 3 or similar strains is another likely possibility.

*Received April*, 1928.

[*Cf.* Abstract 396, p. 266, below.]

# COTTON STATISTICS

BY

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## INDIA

The record of the Indian crop history which is given in Table I. is of special interest this year for several reasons. In the first place, the Supplementary report published on April 26, which generally makes only a few trifling corrections on the figures of the final report of February 23, has this year made a very substantial addition to these figures. The explanation is, first, that the estimate of the Madras crop has been raised by 133,000 acres and 31,000 bales. Further, there is this year for the first time a supplementary report on the Bombay crop, which has also resulted in an increase of the February forecast to the extent of 777,000 acres and 360,000 bales.

As the history of the forecasts for each season is rather interesting, we give the following table showing the change in the forecasts throughout the season for this year and last year:

| *Date.* | 1926–27.* | | | 1927–28. | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *Area.* | | *Crop.* | | *Yield.* | |
| | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Acres.* | *Change (per Cent.).* | *Bales.* | *Change (per Cent.).* | *Lbs.* | *Change (Lbs.).* |
| August .. | 14,739 | — | — | 15,231 | +3·3 | — | — | — | — |
| October .. | 22,055 | — | — | 20,592 | −6·6 | — | — | — | — |
| December | 23,805 | 5,064 | 85 | 23,178 | −2·6 | 5,494 | +8·5 | 95 | +10 |
| February | 24,676 | 5,003 | 81 | 23,812 | −3·5 | 5,480 | +9·5 | 92 | +11 |
| April .. | 24,822 | 5,025 | 81 | 24,722 | −0·4 | 5,871 | +16·9 | 95 | +14 |

* Revised figures throughout.

It will be noticed that the movement this year has been rather remarkable. The area having first been estimated at an increase of 3·3 per cent. on last year's figure was changed over to a reduction of 6·6 per cent. in the second forecast, but this has now been gradually reduced until in the supplementary there is practically no change at all. The crop estimates only begin to appear with the third forecast (December), and it will be seen that the increase on last year's figure, which was only 8·5 per cent. at that time, has now risen to 16·9 per cent.

The final result is very satisfactory. The acreage in 1926-27 showed a very heavy reduction, and that year the crop also suffered very severely, the average yield being the lowest since 1920. In 1927-28, with the acreage practically unchanged in spite of the low prices due to the big American crop of 1926, the crop has made a very good recovery to 5,871,000 bales, though still short of the record totals of over 6 millions in 1925 and 1924, and the average yield is 95 lbs. per acre, being only exceeded by 1921 and 1919.

With regard to Table II., which gives the crop by varieties, distinguishing between short and long staple, we have not thought it necessary this year to repeat the record of the early years, so that the table now gives the figures only since 1924. It is of interest to note that this year again as last year, the short staple varieties give the higher average yield per acre. An examination of the details of these average yields by provinces is very interesting. Unfortunately some of the biggest provinces this year have given very small average yields.

As last year, we have been unable to get Mr. Burt's corrections for those parts of the Broach, Barsi-Nagar and Hyderabad-Gaorani crops which should really be classed under short staple; but making allowance for this the table still shows a very satisfactory total of cotton of ⅞-inch staple and above.

The deletion of the earlier statistics of crop by varieties enables us to repeat the table, which we have not given since July, 1924, of the sub-division of the Indian crop by provinces. In this case also we have cut out the earlier years, beginning the present record with 1914-15.

In accordance with the arrangement mentioned in the April issue, we give this quarter our table of the Smaller Crops other than Empire. The latter are given in a separate table on p. 253. The few estimates available for 1927 are only provisional, but in view of the entire absence of any statistical information as to the others we have refrained from giving estimates which, after all, are nothing but guesswork. It is very unsatisfactory, however, that even in the case of an important country like Brazil it is still impossible to give at this stage a preliminary estimate of the 1927 crop.

### TABLE I.—INDIAN CROP, AREA, YIELD, AND PRICE, 1914–1927.

| *Seasons.* | *Area (Acres).* 000's. | *Crop (Bales of 400 Lbs.).* 000's. | *Yield per Acre.* (*Lbs.*) | *Net Exports and Consumption.* 000's. | *Season's Average Prices.* | |
|---|---|---|---|---|---|---|
| | | | | | *No. 1 Fine Oomra.* | *Per Cent. on American.* |
| 1914–15 .. | 24,595 | 5,209 | 85 | 4,889 | 4·46 | 85 |
| 1915–16 .. | 17.746 | 3,738 | 84 | 5,109 | 6·09 | 81 |
| 1916–17 .. | 21,745 | 4,489 | 83 | 4,985 | 10·32 | 84 |
| 1917–18 .. | 25,188 | 4.000 | 64 | 4,499 | 18·78 | 87 |
| 1918–19 .. | 20,997 | 3,972 | 76 | 3,991 | 18·13 | 92 |
| 1919–20 .. | 23,352 | 5,796 | 99 | 5,343 | 19·23 | 76 |
| 1920–21 .. | 21,340 | 3,600 | 67 | 4,941 | 9·20 | 77 |
| 1921–22 .. | 18,451 | 4,485 | 97 | 5,072 | 9·60 | 85 |
| 1922–23 .. | 21,804 | 5,073 | 93 | 6,270 | 11·14 | 75 |
| 1923–24 .. | 23,631 | 5,161 | 87 | 5,946 | 13·35 | 74 |
| 1924–25 .. | 26,801 | 6,088 | 91 | 6,923 | 11·95 | 87 |
| 1925–26 .. | 28,403 | 6,215 | 88 | 6,508 | 8·97 | 83 |
| 1926–27 .. | 24,822 | 5,025 | 81 | 5,624 | 7·18 | 88 |
| 1927–28 .. | 24,722 | 5,871 | 95 | — | — | — |

## TABLE II.—INDIAN COTTON CROP: AREA, CROP, AND YIELD PER ACRE *BY VARIETIES.*

| *Varieties.* | 1924–25. | | | 1925–26. | | | 1926–27. | | | 1927–28. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* |
| I. *Mainly under ⅞ Inch Staple:* | | | | | | | | | | | | |
| Oomra (Khandeish, Central India, Berar, and Central Provinces) .. | 8,768 | 1,674 | 77 | 8,970 | 1,633 | 73 | 8,224 | 1,573 | 76 | 8,157 | 1,809 | 89 |
| Dhollera .. .. .. .. | 2,578 | 628 | 97 | 3,173 | 630 | 79 | 2,485 | 569 | 92 | 3,057 | 859 | 112 |
| Bengal Sind (United Provinces, Rajputana, Sind Punjab, etc.) .. | 3,671 | 1,070 | 117 | 3,873 | 1,080 | 112 | 3,363 | 822 | 98 | 2,780 | 797 | 115 |
| Comilla, Burma, etc. .. .. | 497 | 112 | 90 | 696 | 150 | 91 | 588 | 114 | 78 | 485 | 103 | 85 |
| Coconada .. .. .. .. | 291 | 57 | 78 | 304 | 54 | 71 | 205 | 30 | 59 | 208 | 38 | 73 |
| Total under ⅞ inch staple .. | 15,805 | 3,541 | 89 | 17,016 | 3,556 | 84 | 14,865 | 3,108 | 83 | 14,687 | 3,606 | 98 |
| Per cent. of total crop .. .. | 59·1 | 58·2 | — | 59·7 | 57·0 | — | 60·0 | 61·9 | — | 59·5 | 61·5 | — |
| II. *Mainly ⅞ Inch Staple and Above:* | | | | | | | | | | | | |
| Punjab (American) .. .. | 964 | 363 | 151 | 1,148 | 359 | 125 | 1,134 | 229 | 81 | 758 | 223 | 118 |
| Sind (American) .. .. .. | 16 | 4 | 100 | 7 | 2 | 114 | 25 | 5 | 80 | 15 | 3 | 80 |
| Broach .. .. .. .. | 1,355 | 345 | 102 | 1,413 | 331 | 94 | 1,211 | 222 | 73 | 1,229 | 243 | 79 |
| Coompta Dharwar .. .. | 1,951 | 333 | 68 | 1,729 | 317 | 73 | 1,513 | 201 | 53 | 1,492 | 281 | 75 |
| Western and Northern .. .. | 2,199 | 345 | 63 | 2,233 | 385 | 69 | 1,795 | 173 | 39 | 1,738 | 253 | 58 |
| Tinnevelly .. .. .. | 621 | 164 | 106 | 705 | 180 | 102 | 525 | 135 | 103 | 526 | 134 | 102 |
| Salem .. .. .. | 235 | 32 | 54 | 194 | 36 | 74 | 181 | 34 | 75 | 194 | 36 | 74 |
| Cambodia .. .. .. .. | 442 | 183 | 166 | 415 | 155 | 149 | 309 | 116 | 150 | 285 | 117 | 164 |
| Barsi and Nagar<br>Hyderabad Gaorani } .. .. | 3,213 | 778 | 97 | 3,631 | 929 | 102 | 3,264 | 802 | 98 | 3,798 | 975 | 103 |
| Total ⅞ inch staple and above .. | 10,996 | 2,547 | 93 | 11,475 | 2,694 | 94 | 9,957 | 1,917 | 77 | 10,035 | 2,205 | 90 |
| Per cent. of total crop .. .. | 40·9 | 41·8 | — | 40·3 | 43·0 | — | 40·0 | 38·1 | — | 40·5 | 38·5 | — |
| Grand total .. .. .. | 26,801 | 6,088 | 91 | 28,491 | 6,250 | 88 | 24,822 | 5,025 | 81 | 24,722 | 5,871 | 95 |

000's omitted throughout in area and crop figures.

### TABLE III.—INDIAN COTTON CROP: AREA

| | 1914–15. | | | 1915–16. | | | 1916–17. | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* |
| Madras .. .. | 2,115 | 245 | 46 | 2,061 | 245 | 48 | 2,168 | 347 | 64 |
| Mysore .. .. | 109 | 14 | 51 | 92 | 14 | 61 | 126 | 16 | 51 |
| Hyderabad .. | 3,605 | 400 | 44 | 2,964 | 450 | 61 | 3,200 | 500 | 62 |
| Bombay .. .. | 6,953 | 1,544 | 89 | 4,439 | 934 | 84 | 6,330 | 1,475 | 93 |
| Sind .. .. | 336 | 116 | 148 | 161 | 48 | 119 | 240 | 78 | 130 |
| Baroda .. .. | 843 | 229 | 109 | 566 | 117 | 83 | 707 | 171 | 97 |
| Central Provinces and Berar .. | 4,708 | 1,097 | 93 | 4,061 | 1,106 | 109 | 4,402 | 691 | 63 |
| Central India .. | 1,519 | 293 | 77 | 909 | 216 | 86 | 1,419 | 311 | 88 |
| Gwalior .. .. | | | | | | | | | |
| Bengal .. .. | 90 | 34 | 151 | 88 | 30 | 136 | 73 | 20 | 110 |
| Bihar and Orissa .. | 70 | 16 | 91 | 67 | 16 | 96 | 68 | 16 | 94 |
| United Provinces .. | 1,551 | 486 | 123 | 834 | 262 | 126 | 1,185 | 309 | 104 |
| Rajputana .. .. | 421 | 166 | 157 | 244 | 62 | 102 | 334 | 128 | 153 |
| Ajmer Merwara .. | 54 | 15 | 111 | 23 | 2 | 35 | 47 | 35 | 300 |
| Punjab .. .. | 1,857 | 486 | 105 | 902 | 195 | 86 | 1,163 | 335 | 115 |
| North-West Frontier | 60 | 14 | 93 | 26 | 4 | 62 | 28 | 6 | 86 |
| Assam .. .. | 34 | 12 | 142 | 32 | 10 | 125 | 32 | 11 | 137 |
| Burma .. .. | 270 | 42 | 62 | 187 | 27 | 58 | 223 | 40 | 72 |
| Total .. .. | 24,595 | 5,209 | 85 | 17,746 | 3,738 | 84 | 21,745 | 4,489 | 83 |

| | 1921–22. | | | 1922–23. | | | 1923–24. | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* |
| Madras .. .. | 1,803 | 341 | 76 | 2,348 | 431 | 73 | 2,658 | 483 | 73 |
| Mysore .. .. | 59 | 15 | 102 | 83 | 24 | 116 | 84 | 15 | 71 |
| Hyderabad .. | 2,914 | 870 | 119 | 3,813 | 1,116 | 117 | 3,500 | 1,079 | 123 |
| Bombay* .. .. | 4,678 | 1,137 | 97 | 5,819 | 1,329 | 91 | 6,791 | 1,213 | 72 |
| Sind .. .. | (Now included in Bombay) | | | | | | | | |
| Baroda .. .. | 600 | 85 | 57 | 585 | 116 | 79 | 657 | 76 | 46 |
| Central Provinces and Berar .. | 4,414 | 1,127 | 102 | 4,857 | 1,040 | 86 | 4,933 | 1,020 | 83 |
| Central India .. | 714 | 158 | 89 | 889 | 181 | 81 | 1,041 | 184 | 70 |
| Gwalior .. .. | 335 | 46 | 52 | 523 | 74 | 57 | 500 | 60 | 48 |
| Bengal .. .. | 65 | 15 | 92 | 72 | 17 | 94 | 71 | 21 | 118 |
| Bihar and Orissa .. | 79 | 15 | 76 | 80 | 15 | 75 | 81 | 16 | 79 |
| United Provinces .. | 828 | 244 | 118 | 664 | 180 | 109 | 654 | 213 | 130 |
| Rajputana .. .. | 297 | 68 | 92 | 302 | 76 | 101 | 330 | 73 | 90 |
| Ajmer Merwara .. | 26 | 12 | 185 | 36 | 15 | 167 | 41 | 13 | 127 |
| Punjab .. .. | 1,239 | 296 | 96 | 1,394 | 397 | 114 | 1,927 | 630 | 131 |
| North-West Frontier | 15 | 3 | 80 | 15 | 3 | 80 | 23 | 5 | 87 |
| Assam .. .. | 40 | 13 | 130 | 40 | 14 | 140 | 39 | 14 | 144 |
| Burma .. .. | 325 | 40 | 49 | 284 | 45 | 63 | 301 | 46 | 61 |
| Total .. .. | 18,451 | 4,485 | 97 | 21,804 | 5,073 | 93 | 23,631 | 5,161 | 87 |

* Including Native States, also Sind and Delhi, since 1921.

CROP AND YIELD PER ACRE *BY PROVINCES.*

| 1917–18. | | | 1918–19. | | | 1919–20. | | | 1920–21. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* |
| 2,592 | 450 | 69 | 3,133 | 581 | 74 | 2,339 | 408 | 70 | 2,150 | 358 | 67 |
| 154 | 23 | 60 | 125 | 14 | 45 | 145 | 18 | 50 | 111 | 11 | 40 |
| 3,451 | 450 | 52 | 2,406 | 643 | 107 | 3,095 | 749 | 97 | 2,214 | 341 | 62 |
| 7,697 | 1,403 | 73 | 5,547 | 641 | 46 | 5,857 | 1,505 | 103 | 5,688 | 927 | 65 |
| 267 | 53 | 79 | 317 | 114 | 144 | 319 | 84 | 105 | 275 | 42 | 61 |
| 914 | 239 | 105 | 814 | 81 | 40 | 794 | 127 | 64 | 792 | 127 | 64 |
| 4,582 | 591 | 52 | 4,135 | 807 | 78 | 4,600 | 1,289 | 112 | 4,477 | 514 | 46 |
| 1,454 | 116 | 32 | 1,236 | 214 | 69 | 1,591 | 219 | 55 | 876 | 119 | 54 |
| | | | (Previously included in Central India) | | | | | | 456 | 43 | 38 |
| 71 | 19 | 107 | 73 | 32 | 175 | 69 | 25 | 145 | 71 | 21 | 118 |
| 69 | 17 | 99 | 79 | 20 | 101 | 78 | 17 | 87 | 78 | 15 | 77 |
| 1,315 | 198 | 60 | 862 | 174 | 81 | 1,268 | 436 | 138 | 1,161 | 337 | 116 |
| 435 | 54 | 50 | 250 | 55 | 88 | 371 | 99 | 107 | 375 | 81 | 86 |
| 70 | 14 | 80 | 30 | 14 | 187 | 44 | 24 | 218 | 42 | 15 | 143 |
| 1,800 | 307 | 68 | 1,550 | 493 | 127 | 2,269 | 682 | 120 | 2,142 | 588 | 110 |
| 38 | 5 | 53 | 39 | 7 | 72 | 51 | 11 | 86 | 27 | 5 | 74 |
| 32 | 13 | 162 | 32 | 12 | 150 | 32 | 14 | 175 | 39 | 14 | 144 |
| 247 | 48 | 78 | 369 | 70 | 76 | 430 | 89 | 83 | 366 | 42 | 46 |
| 25,188 | 4,000 | 64 | 20,997 | 3,972 | 76 | 23,352 | 5,796 | 99 | 21,340 | 3,600 | 67 |

| 1924–25. | | | 1925–26. | | | 1926–27. | | | 1927–28. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* | *Area (Acres).* | *Crop (Bales).* | *Yield per Acre (Lbs.).* |
| 2,903 | 567 | 78 | 2,921 | 569 | 78 | 2,231 | 388 | 70 | 2,079 | 422 | 81 |
| 118 | 36 | 122 | 83 | 25 | 120 | 97 | 25 | 103 | 81 | 25 | 123 |
| 3,412 | 899 | 105 | 3,781 | 1,060 | 177 | 3,267 | 808 | 99 | 3,631 | 951 | 105 |
| 7,717 | 1,590 | 82 | 8,123 | 1,567 | 77 | 6,918 | 1,290 | 75 | 7,691 | 1,792 | 94 |
| 658 | 171 | 104 | 866 | 189 | 87 | 761 | 124 | 65 | 806 | 127 | 63 |
| 5,247 | 1,000 | 76 | 5,385 | 980 | 73 | 4,864 | 977 | 80 | 4,848 | 1,145 | 94 |
| 1,354 | 259 | 77 | 1,369 | 270 | 79 | 1,297 | 223 | 69 | 1,263 | 247 | 78 |
| 699 | 145 | 83 | 651 | 116 | 71 | 649 | 107 | 66 | 585 | 115 | 79 |
| 77 | 24 | 125 | 78 | 26 | 133 | 77 | 25 | 130 | 78 | 20 | 103 |
| 79 | 14 | 71 | 82 | 15 | 73 | 79 | 14 | 71 | 77 | 14 | 73 |
| 1,049 | 276 | 105 | 1,004 | 277 | 110 | 809 | 259 | 128 | 647 | 200 | 124 |
| 418 | 89 | 85 | 411 | 93 | 91 | 404 | 78 | 77 | 422 | 110 | 104 |
| 45 | 15 | 133 | 54 | 17 | 126 | 43 | 15 | 140 | 42 | 14 | 133 |
| 2,589 | 910 | 141 | 3,052 | 908 | 119 | 2,803 | 599 | 85 | 2,074 | 605 | 117 |
| 39 | 8 | 82 | 32 | 7 | 87 | 30 | 5 | 67 | 11 | 2 | 73 |
| 45 | 15 | 133 | 47 | 13 | 111 | 46 | 15 | 130 | 45 | 15 | 133 |
| 352 | 70 | 80 | 464 | 83 | 72 | 447 | 73 | 65 | 342 | 67 | 78 |
| 26,801 | 6,088 | 91 | 28,403 | 6,215 | 88 | 24,822 | 5,025 | 81 | 24,722 | 5,871 | 95 |

000's omitted throughout in area and crop figures.

### TABLE IV.—SUMMARY OF THE SMALLER COTTON CROPS (OTHER THAN EMPIRE), 1914–1927.

In 000's of 500 lb. Bales Approximately.

| | 1914. | 1915. | 1916. | 1917. | 1918. | 1919. | 1920. | 1921. | 1922. | 1923. | 1924. | 1925. | 1926. | 1927. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brazil .. .. .. | 406 | 296 | 341 | 413 | 486 | 552 | 424 | 483 | 519 | 514 | 630 | 593 | 448 | — |
| Peru .. .. .. | 123 | 115 | 128 | 130 | 136 | 183 | 164 | 183 | 185 | 196 | 193 | 187 | 227 | 250 |
| Mexico .. .. .. | 112 | 100 | 106 | 110 | 237 | 203 | 220 | 169 | 191 | 168 | 257 | 205 | 370 | 156 |
| Argentine .. .. .. | 5 | 5 | 5 | 10 | 12 | 13 | 26 | 19 | 28 | 61 | 72 | 138 | 57 | 154 |
| Other South American .. | 9 | 8 | 8 | 9 | 9 | 7 | 30 | 41 | 37 | 85 | 84 | 89 | 99 | — |
| West Indies (foreign) .. | 13 | 15 | 11 | 11 | 12 | 16 | 13 | 22 | 17 | 17 | 18 | 20 | 20 | — |
| Japan and Korea .. .. | 68 | 63 | 63 | 79 | 92 | 118 | 127 | 128 | 205 | 197 | 183 | 188 | 240 | 135 |
| East Indies, etc. .. .. | 71 | 69 | 77 | 73 | 68 | 90 | 67 | 36 | 26 | 22 | 23 | 25 | 28 | — |
| Persia .. .. .. | 131 | 127 | 91 | 72 | 66 | 84 | 73 | 68 | 75 | 91 | 93 | 99 | 110 | — |
| Europe and Asia Minor .. | 148 | 123 | 130 | 117 | 108 | 125 | 116 | 52 | 56 | 116 | 144 | 176 | 181 | — |
| Africa (foreign) .. .. | 3 | 3 | 7 | 5 | 6 | 12 | 13 | 18 | 26 | 46 | 72 | 86 | 107 | — |
| Total .. .. .. | 1,089 | 924 | 967 | 1,029 | 1,232 | 1,403 | 1,273 | 1,219 | 1,365 | 1,543 | 1,779 | 1,806 | 1,917 | — |

## EMPIRE COTTON CROPS FOR NINE YEARS 1919–27, EXCLUDING INDIA.

(*In bales of* 400 *lbs.*)

The seasons are given as covering two years (*e.g.*, 1926–1927) because in the majority of the countries named planting takes place in one calendar year and picking in the next. In a few of these countries, however (*e g.*, Tanganyika, Iraq, Cyprus, Malta), the crop is harvested in the same year as that in which it is planted. In such cases the figures should be read as relating to the crop grown in the *latter* of the two years at the head of the column.*

| COUNTRY. | 1918–19. | 1919–20. | 1920–21. | 1921–22. | 1922–23. | 1923–24. | 1924–25. | 1925–26. | 1926–27. (Figures in italics are estimates only.) |
|---|---|---|---|---|---|---|---|---|---|
| (1) Anglo-Egyptian Sudan .. | 15,997 | 23,160 | 30,519 | 24,074 | 28,306 | 47,652 | 44,912 | 121,131 | 148,118 (1) |
| (2) Gold Coast .. .. .. | 52 | — | 61 | 49 | 15 | 93 | 1,132 | 1,218 | 285 (2) |
| (3) Nigeria .. .. .. | 17,500 | 16,200 | 30,000 | 15,096 | 16,811 | 25,694 | 30,137 | 47,909 | 27,464 (3) |
| (4) Uganda .. .. .. | 36,530 | 47,694 | 81,365 | 48,290 | 88,046 | 128,604 | 196,038 | 180,859 | 131,728 (4) |
| (5) Kenya .. .. .. | 100 | 100 | 500 | 417 | 1,200 | 1,653 | 2,250 | 2,016 | 1,232 (5) |
| (6) Nyasaland .. .. .. | 2,591 | 2,026 | 4,615 | 5,422 | 4,036 | 6,873 | 7,718 | 4,976 | 2,792 (6) |
| (7) Northern Rhodesia.. .. | 56 | 35 | 100 | 80 | 102 | 500 | 379 | 506 | 32 (7) |
| (8) Southern Rhodesia.. .. | — | — | — | — | — | 1,650 | 4,907 | 6,803 | 639 (8) |
| (9) Tanganyika .. .. .. | — | — | 7,327 | 7,175 | 11,434 | 18,793 | 21,724 | 24,280 | 16,650 (9) |
| (10) Union of South Africa and Swaziland.. .. .. | 1,911 | 2,737 | 2,923 | 2,740 | 6,523 | 8,730 | 16,936 | 20,381 | 10,242 (10) |
| (11) West Indies.. .. .. | 6,086 | 6,170 | 4,824 | 4,073 | 5,160 | 5,031 | 4,051 | 5,148 | 5,909 (11) |
| (12) Queensland .. .. .. | 31 | 38 | 792 | 3,140 | 9,344 | 11,850 | 14,318 | 7,179 | 5,883 (12) |
| (13) Cyprus .. .. .. | 3,325 | 2,687 | 2,547 | 1,505 | 2,233 | 3,397 | 3,320 | 4,614 | 7,029 (13) |
| (14) Malta .. .. .. | 343 | 266 | 582 | 193 | 118 | 573 | 782 | 507 | *342* (14) |
| (15) Iraq .. .. .. .. | — | 60 | 60 | 300 | 1,100 | 2,400 | 2,540 | 3,500 | *1,800* (15) |
| (16) Fiji .. .. .. .. | — | — | — | — | — | 83 | 153 | 120 | 797 (16) |
| (17) Ceylon .. .. .. | — | — | — | — | 49 | 324 | 121 | 261 | 186 (17) |
|  | 84,522 | 101,173 | 166,215 | 112,554 | 174,477 | 263,900 | 300,418 | 431,438 | 361,128 |
|  |  | *Percentage Increase* 19·7. | *Percentage Increase* 64·2. | *Percentage Decrease* 32·2. | *Percentage Increase* 55·0. | *Percentage Increase* 51·2. | *Percentage Increase* 36·6. | *Percentage Increase* 19·7. |  |

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* The adoption of this practice for the purpose of giving consistency to the records has necessitated the transference of the figures for certain countries to a previous column. The totals in this table will consequently be found to differ slightly from those previously published.

# NOTES ON CURRENT LITERATURE

## *COTTON IN INDIA.*

344. Report upon Cotton Investigations in the Central Provinces for 1926-27. By W. Youngman. From this Report, recently received, we learn, in reference to the efforts that have been made to obtain pure strains of the various types of Indian cotton, that the Agricultural Research Institute, Nagpur, is now in a position to supply almost any of the types as recognized by Gammie in a pure form.

The Report also contains an account of the hybridizing work that is going on, chiefly with the idea of studying known unit characters, as few as possible at a time, and applied especially to the elucidation of knowledge of the *neglectum* group of cottons. Analyses are included of the genetic behaviour of *G. neglectum verum*, and work upon Chandi jari and Buri cotton is described.

345. Cotton Cultivation in the Punjab (Abstr. from the *Rpt. of the Dpt. of Agr. for the year ended June* 30, 1927, recently received). We quote the following: "The year was climatically a poor one for cotton, and although 2,500,000 acres were planted, the yield was only about half that of 1925. The causes of the failure are still obscure, but Government trusts that special attention will be given to the production of disease-free seed.

"It is interesting to find that the improved *Desi* cottons, owing to their yield and higher ginning and pressing percentage, are becoming increasingly popular, and were planted over double the area of the previous year. The Director of Agriculture rightly draws attention to the loss which accrues to cultivators owing to the evil practice of mixing cotton, and Government is glad to know that the provisions of the Cotton Ginning and Pressing Factories Act are not being allowed to become a dead letter.

"Mr. Trought, the Cotton Research Botanist, provided by the Indian Central Cotton Committee, continued work on the same lines as in the previous year. At Lyallpur the main work was Pure Line Selection of American and Desi types. A total of 175 families was grown, and botanical observations were made on these families throughout the season; 1,150 plants were chosen for laboratory records on seed and lint characters, with a view to the further selection of plants for pure line parents in 1927. A few duplicated pure line families were grown at other selected localities for comparison.

"The Pink Bollworm investigation scheme, financed by the Indian Central Cotton Committee, was started in May, 1926. The main object of the scheme is a thorough determination over a series of years of the actual incidence of the Pink Bollworm (*Platyedra gossypiella*) in the canal colonies and the south-eastern tract of the province, and to correlate this with the climatic factors which influence the spread of the pest in the Punjab. The work is being conducted at three different stations, Lyallpur, Rohtak, and Sialkot.

"In addition to the Pink Bollworm, the Spotted Bollworm was present generally, and the attack of Jassid and White Fly was considerable.

"During the year under review, soil temperatures were recorded for the first time, and were found to rise to a considerable height, even at 30 cms. depth, and to be much higher than temperatures similarly recorded in Egypt. Canal water supply was sufficient, and no complaints were received of shortage."

346. Bombay Cotton Research. (Abstr. from *Text. Rec.*, xlv., 537, 1927, p. 89.) The study of cotton boll shedding at Surat, which was in progress during

the last three years, seems to suggest two lines of advance for further work. One of these lies in the development of strains of cotton with a small loss of buds and bolls; the other lies in regulation of the moisture content of the soil and subsoil in the latter part of the season. In regard to the investigation of the cotton wilt disease, the Agricultural Department has succeeded in breeding a type of Kumpta cotton which has all the desirable qualities of the best strains, but is immune to wilt disease.

347. LE COTON AUX INDES ANGLAISES. By — du Pasquier. (Abstr. in *Coton et Culture Cotonnière*, ii., 3, 1927, p. 139.)

348. COTTON MILLS IN INDIA. VENTILATION AND HUMIDIFICATION. (*Ind. Text. J.*, 1928, 38, 125-6. Abstr. from *Summ. of Curr. Lit.*, viii., 7, 1928, M. 10.) A report of investigations in regard to the ventilation and humidification of cotton mills in Bombay, and the advisability of adopting a ventilation standard based on the cooling power of the atmosphere as measured by the Kata thermometer. In reply to questions asked by the Government, the Millowners' Association pointed out that a Kata standard of 11, as recommended by the adviser on humidification, was an ultimate ideal ruled out at present by the heavy costs which would be entailed. The adoption of a lower Kata standard would necessitate expensive alterations in many factories, and in others might hinder contemplated improvements. It was, therefore, recommended that no Kata standard should be enforced.

349. LABOUR CONDITIONS IN INDIAN COTTON MILLS. (*Int. Cot. Bull.*, vi., 22, 1928, p. 340.)

## *COTTON IN THE EMPIRE (EXCLUDING INDIA).*

350. IMPERIAL ECONOMIC COMMITTEE. We have received from the Secretary a leaflet entitled *Our best Customers*, which, in summarizing the Eighth Report of the Imperial Economic Committee, describes the rise in exports sent to the overseas Empire in recent years, and points out the advantages to be gained by trading within the Empire. The Report is published by H.M. Stationery Office at 6d. net.

351. BRITISH COTTON GROWING ASSOCIATION. The twenty-third Annual Report provides the usual interesting reading. It is stated that notwithstanding the continued depression in the cotton trade of this country, there has again been a satisfactory demand for cotton of outside growths of good grade and staple, and the total sales of such cotton—viz., other than cotton from the U.S.A. and Egypt, during the season ended July 31, 1927—amounted to 878,440 bales, as follows:

| | | |
|---|---|---|
| South African .. .. .. .. .. | 14,840 | bales. |
| East African .. .. .. .. .. | 117,740 | " |
| West African .. .. .. .. .. | 42,600 | " |
| Brazilian, etc. .. .. .. .. .. | 105,860 | " |
| Peruvian, etc. .. .. .. .. .. | 369,700 | " |
| Sudan (Sakel and other Sudan) .. .. | 188,800 | " |
| West Indian .. .. .. .. .. | 9,920 | " |
| Sea Island .. .. .. .. .. | 2,200 | " |
| East Indian, etc. .. .. .. .. | 15,650 | " |
| Australian .. .. .. .. .. | 4,560 | " |
| Sundries .. .. .. .. .. .. | 6,570 | " |
| Total= | 878,440 | bales. |

The total sales of Empire grown cotton show a large increase over the previous year, especially Sudan cotton, which has increased from 39,820 to 188,800 bales.

The total number of bales and the value of the cotton which has been dealt with by the Association during the last two years is as follows:

| | *Bales.* | *Value.* |
|---|---|---|
| 1926 | 135,522 | £3,368,740 |
| 1927 | 171,600 | 5,012,084 |

Detailed accounts are given of the work carried on in the various countries of the Empire. The approximate value of the Empire crop for 1927 is given at over £9,000,000. The Report is furnished with several interesting illustrations, and there are the usual statistical appendices.

352. EUROPE: CYPRUS. *Cotton Cultivation.* (Abstr. from the *Cyprus Agr. Jour.*, xxiii., 2, April, 1928, p. 41.) It is stated that there was a marked decline in the yield of cotton in 1927, which was mainly attributed to lack of rain, since there was no record of disease having appeared.

353. *Cyprus Brown Cotton—The Native Brown Lint.* (Extracted from the *Cyprus Agr. Jour.*, xxiii., 1, 1928, p. 14.) In February, 1927, a sample of Cyprus brown cotton, weighing 5 lbs., was sent to the British Cotton Industry Research Association through the Trade Commissioner, London, for experimental work, and the following report has been received from the Association:

"We have been interested in the Cyprus native cotton on account of its high colour, and have not examined it from any other point of view. It has one very interesting chemical property which is definitely associated with the colour—viz., very high reducing power compared with less coloured varieties. This is measured by the 'copper number' of the sample.

"In the case of American and Egyptian cottons, the copper number ranges from 1 to 1·5, and the bulk of the reducing substances are soluble in water, the copper number falling to a value of 0·3 to 0·5 on thorough washing with water; similarly, although Indian cotton may have the copper numbers as high as 3, washing reduces them to values of the order of 0·4. Brown Cyprus and other highly coloured cottons, however, are characterized by high copper numbers which remain high after thorough washing with water. For example, the Cyprus Brown Native sample supplied had initially a copper number of 8·4, which fell only to 6·2 on thorough washing with water, whilst Gold Coast native showed a value of 5·9 before washing and 5·8 after washing."

354. ASIA: CEYLON. *Cotton Cultivation.* (Abstr. from *Trop. Agriculturist*, lxx., 3, 1928, p. 158.) Mass selection in cotton to provide selected seed for the cotton-growing area in the Hambantota District is being made by the Divisional Agricultural Officer, Southern Division.

355. AFRICA: TRANSPORT IN EAST AFRICA. (Abstr. from *East Africa*, iv., 186, 1928, p. 1025.) The new Tabora-Mwanza line is now within about forty miles of the Lake Victoria port.

356. NIGERIA. *Cotton Cultivation.* From the address delivered by His Excellency the Governor at the Sixth Session of the Legislative Council of Nigeria, held at Lagos in February last, we abstract the following information in reference to cotton cultivation.

The purchases of cotton in Northern Nigeria during the last season turned out to be disappointingly small, as a result of adverse weather conditions and low prices. Consequent on the latter a much larger amount of cotton was absorbed locally.

In regard to the present season (1927-28), the Director of Agriculture is of opinion that in spite of the greater area devoted to food crops, as a natural reaction to the recent threat of famine in the North, the area planted to cotton is roughly comparable to that of 1924-25, which yielded 28,000 bales. It is hoped that the lost ground will soon be recovered, and steady progress renewed again.

In the Ilorin Province, all work in the extension of cotton production has been suspended, pending the result of the scientific work which has been started there, which aims at the production of a superior variety of native cotton suited to the local conditions.

Efforts are being made in Oyo and Abeokuta to multiply the seed of the "Ishan" type of cotton, in order that there may be enough seed for every farmer who wants it. The agricultural officers are of opinion that when a farmer has a native cotton that is really worth growing for export, he will grow it in nearly every yam field; and although cotton grown in this way naturally does not yield as heavily as it does when grown alone, yet it yields something, and the large area will make the total considerable.

**357.** The *Sixth Ann. Bull. of the Agr. Dpt., Nigeria,* 1927, gives particulars of various experiments with cotton—including time of planting, manurial, and varietal tests, and also experiments on growing cotton with yams and with groundnuts—carried out in 1926 at Moor Plantation, Ibadan; Ilorin; Samuru Agricultural Station, Zaria; Kano Agricultural Station. Tables showing the details of the experiments are included.

**358.** *A Critical Comparison of the Factors Inhibiting the Development of Three Species of Cotton in Southern Nigeria.* By F. D. Golding, Owen B. Lean, and T. Laycock. (Abstr. from the *Sixth Ann. Bull. of the Agr. Dept., Nigeria,* 1927, p. 5). A detailed survey was made of the factors inhibiting the development of Allen, Ishan and Meko cottons grown on Moor Plantation, Ibadan, and at Adio in forest country four miles to the west of the first-named locality. The main conclusions drawn from the data obtained from this survey are as follows:

(1) Both Ishan and Meko gave considerably higher yields than Allen. Of the two native varieties, Ishan was less subject to all diseases except leaf curl, and gave a higher yield of *clean* seed cotton than Meko. (N.B.—The improved strains of Ishan, bred by Mr. Lewin, are not only superior to Allen and Meko in lint qualities, but, in two cases, exhibit a considerable degree of immunity to the virus disease, leaf curl.)

(2) The close season measures, carried out from 1923 to 1925, in an area of nine square miles surrounding Moor Plantation, were completely ineffective as a control for cotton stainers, and had little, if any, controlling effect on bollworms. Although flight experiments with stainers (in 1924) showed that the area was too small, the application of close season measures on a large scale in Southern Nigeria is regarded as impracticable on account of local conditions and expenditure.

(3) A late-flowering cotton would avoid, to a large extent, heavy stainer infestation in a normal year. The Ishan strains exhibiting this characteristic (bred by Mr. Lewin) will, in all probability, suffer little from stainers—the most important factor inhibiting the development of cotton in Southern Nigeria.

**359.** RHODESIA (NORTHERN). *Cotton Cultivation.* (Abstr. from the *Ann. Rpt. of the Dpt. of Agr.,* 1927, recently received.) It is stated in this Report that the failure of the cotton crops during the past two seasons, which were characterized by abnormally adverse climatic conditions, has resulted in many farmers being averse to cultivating this crop. It is certain that cotton should be given a trial over a number of seasons before a definite announcement is made as to its value, or otherwise, as an export crop for Northern Rhodesia, and it is hoped that farmers will plant experimental acreages with a view to obtaining the required information. Ample evidence exists as to the utility of cotton as a rotation crop for maize, since in practically every instance where maize has been planted on lands following cotton, the yield has been considerable.

The Report continues: "Experiments are proceeding in almost all parts of Africa where cotton is looked upon as an established or potential crop, to endeavour to obtain a plant which will be resistant to some of the diseases or pests which have been encountered, and work is also being carried out with a view to obtaining means for controlling the ravages of certain insect pests. This work is being actively prosecuted by the Governments concerned and by the staff of experts maintained by the Empire Cotton Growing Corporation. The staff of our own research station is in touch with the investigators, and during the present season plots have been planted with varieties of seed supplied by them. There can be no doubt of the benefit to this Territory which would result from the inclusion of cotton as one of the staple crops, and every endeavour will be made to obtain the information which is necessary before large acreages can be recommended. In order to assist farmers during the 1927-28 season, the Empire Cotton Growing Corporation provided seed which has been supplied free of charge to all who have applied for it."

**360.** SOUTH AFRICA. *Cotton Prospects.* (Abstr. from *Int. Cot. Bull.*, vi., 23, 1928, p. 433.) Reports from the cotton-growing districts continue to be generally good, there having been only slight damage from hail and insect pests. The outlook for the industry is stated to be brighter than it has been for several seasons.

**361.** SUDAN. *Cotton Prospects.* (Abstr. from the *Mnthly. Rpt. of the Coml. Intell. Branch*, Cen. Econ. Board, April, 1928, p. 93.) In the Red Sea Province all cotton is laden with bolls, is flowering very well, and a few sunny days should result in heavy pickings. The quality of cotton has been very good, 84 per cent. of that picked during the month being first-class cotton. In the Blue Nile Province it is expected that the yield of cotton on the Gezira Irrigation Scheme will be in the neighbourhood of 3·25 kantars per feddan (309 lbs. per acre).

**362.** *Sudan Irrigation and Agriculture. Cotton Cultivation.* By P. D. Clark. (*Times East Afr. and Sudan Number*, March 13, 1928, p. 23.) North of the thirteenth parallel of latitude irrigation is a necessity for the Sudan, and the great Sennar Dam was constructed to meet this need. Something over 400,000,000 tons of water are available. In 1927 more than 300,000 acres were under cultivation, one-third being under cotton. The land is all owned by natives, and the cotton-growing industry is worked on a system of co-partnership between the Government, the Sudan Plantations Syndicate—who are the Government's managing agents—and the native cultivator, each of the three partners taking a percentage of the receipts from the sale of the cotton. How it affects the native may be indicated as follows: The average yield of the 300,000 acres before the inauguration of the scheme was dura worth £100,000, and on this and a certain number of animals the people lived. At present, if an acre of cotton is worth £20—which is a conservative estimate at present prices—the total value of the cotton crop is £2,000,000, of which the native's share is 40 per cent., that is £800,000. An individual tenant with a 30-acre holding, one-third under cotton, would get £80, his expenses in producing it would be about £40, and he would make £40 profit. In addition, he will get a good supply of dura on the rest of his holding, and extra food for his animals.

The Lancashire mills are already receiving from the Gezira 100,000 bales a year of the highest grade long-staple cotton.

**363.** *Cotton Growing at the Gezira Research Farm. With a Brief Account of Some of the Experimental Plots.* By V. P. Walley. (A paper read and discussed at a meeting of research workers engaged in Cotton Research in the Sudan.) The following extracts are of interest: "For many years the seed was sown before the land was watered; for the past two seasons, however, the land has been irrigated prior to sowing, a method similar to native cultivation of rain cotton, and the results appear encouraging. Experiments have shown that July 15—the original date for commencing sowing—is definitely too early; better results have been obtained by sowing on August 15. It was customary to use seed from the previous season's cotton; there appears to be evidence that seed used from plants grown season after season results in plant deterioration and a change of seed every two or three seasons would appear to be indicated. Last season, seed imported from Egypt and Tokar gave remarkably good results; of the two sources the latter seems preferable; Egyptian seed has given poorer germination owing to the amount of dead seed present.

"The Gezira Research Farm consists of seventy-six plots of five feddans each. In the main, the experiments have been arranged as follows:

"A. Three-course rotation for the following experiments:

- (*a*) Water duty.
- (*b*) Dates of sowing and thinning.
- (*c*) Manurial trials.
- (*d*) Cultivation trials.
- (*e*) Variety tests.

"B. Various trials.

- (*a*) One, two, three course rotations.
- (*b*) Observation plots.
- (*c*) Strains of cotton plots.

"Even with sufficient replication and the correct scatter of plots, several factors might affect the final yield.

1. Treatment of the land prior to sowing.
2. Inter-row cultivation after sowing.
3. Watering.
4. Method of picking.

"The usual treatment (prior to sowing) consists of cultivating the land during October, November, and December, and ridging in the following spring. Inter-row cultivation after sowing varies considerably. The initial weeding seems to be all-important, possibly owing to the small percentage of available nitrogen in the surface soil. If the cotton plant be deprived of this, a bad start is made, and it is more liable to disease. Cotton in the Gezira normally receives twelve to sixteen waterings during its growth."

A brief account is then given of a few interesting experimental plots at the Research Farm. Plot 4 (Continuous Cotton) is now growing its ninth crop under irrigation, and up till the end of last season produced a total of 15·69 kantars of cotton per feddan, or an average of 1·96 kantars per season. Two-course Rotation Plots, 1, 2, and 3, show that rotation with lubia is definitely the best.

**364. Tanganyika.** A report received from H.M. Eastern African Dependencies Trade and Information Office is to the effect that at the end of April the cotton prospects in most of the districts of the Territory were good.

**365.** *Cotton Cultivation.* (Abstr. from *Times East Afr. and Sudan Number*, March 13, 1928, p. 15.) The cotton-growing areas in Tanganyika are widespread. The conditions are, however, varied, and the times of planting and harvesting depend upon the locality and the climate. The Mwanza Province is the main producing area, other contributing parts being Lindi, on the coast, the Morogoro and Kilossa districts, on the main line of railway, and the Tanga and Northern Provinces, while a small amount is produced in the Bukoba district. Under efficient organization Tanganyika has great possibilities for an extension of her cotton areas, not least of which are the enormous suitable areas in the valley and delta of the Rufigi River.

**366. UGANDA.** *Cotton Prospects.* From the latest report received from the Department of Agriculture, we learn that in the Eastern Province the marketing of the crop has practically finished, and the uprooting and burning of the old plants is being carried out in all districts. The drought continued throughout the greater part of March, but at the end of the month conditions were more favourable.

In the Buganda Province, weather conditions continued to be favourable for the marketing of the crop, and the quality has been well maintained. The quantities of cotton offered for sale gradually diminished towards the end of March, but the total for the quarter shows a very satisfactory increase when compared with the figure for the same period last year.

**367.** *Cotton Cultivation.* (Abstr. from *Times East Afr. and Sudan Number,* March 13, 1928, p. 15.) Uganda is by nature eminently suited for the production of cotton, with its great systems of vast, natural waterways. According to Mr. S. Simpson, the Director of Agriculture, the long-stapled American "Upland" types of "Allen" and "Sunflower" were found to be the most suitable varieties for Uganda conditions, but these are giving place gradually to types derived from "Nyasaland Upland." Of these, a variety known as N. 17, evolved from Nyasaland seed at the Experimental Station at Serere in the Eastern Province, appears to be the most promising. It is proposed to distribute the seed throughout the country as it becomes available.

Uganda cotton has a fairly strong staple, full $1\frac{1}{8}$ to $1\frac{3}{16}$ inches in length, and is of a light creamy tinge. Spinners use this cotton for counts ranging from 30's to 40's twist and from 42's to 64's weft, thus taking the place of stapled American and Upper Egyptian.

**368.** *The Importance of Cotton.* By R. S. D. Rankin. (Abstr. from *Times East Afr. and Sudan Number,* March 13, 1928, p. 21.) From this article we quote the following: "The amazingly rapid development of cotton production brought in its train new problems and complicated others, and our efforts today are aimed at the solution of these problems. Briefly, they are: the provision of further transport facilities, the examination of the possibilities of other economic products, and the social advancement of the native races in the distracting influence of newly and rapidly acquired wealth.

"The transport problem became the matter of immediate import, and through the aid of the Imperial Government it has been possible to deal with it fairly effectually. Before the European entered the country, the native rulers had built up a unique road system; this system has been extended and improved, so that there is today a network of excellent motor roads connecting even the outlying districts of the Protectorate. The road system of Uganda is, in fact, unsurpassed throughout East Africa, and it is in a large measure through road development that the rapid extension of cotton cultivation has been made possible."

**369.** *Transport.* (Abstr. from *Trop. Agriculture,* v., 4, 1928, p. 86.) The Tororo-Mbulamuti-Jinja extension of the Kenya and Uganda Railway has been opened, and large cotton-producing areas of Uganda will thus be provided with a direct railway outlet to the coast. Hitherto, communications from Uganda to the sea have been by way of steamer from one of the Lake Victoria ports and Kisumu, the former terminus of the Uganda Railway.

The new line, which has been constructed from the 3½ million loan voted by Parliament in 1924, runs from Mbulamuti (a point on the short line running from Jinja, on Lake Victoria, to Namasagali, on Lake Kioga) through one of the main cotton-producing areas to Tororo, near the Kenya border. The line then passes across the North Kavirondo district of Kenya and, joining the Uasin Gishu Railway, connects with the old main line at Nakuru. Mbulamuti is on the bank of the Victoria Nile, and 106 miles from the Kenya-Uganda border.

370. THE WEST AFRICAN EDUCATIONAL SYSTEM. SOME NEW EXPERIMENTS. By the Rev. A. G. Fraser, Principal of the Prince of Wales's College, Achimota, Gold Coast. (*The Commercial, British West Africa Number*, November 24, 1927, p. 29.)

371. WEST INDIES. *Cotton in Antigua.* (Abstr. from the *West Ind. Comm. Circ.*, xliii., 771, 1928, p. 147.) From the report on the Leeward Islands for the year 1926 by the Hon. Edward Baynes, we learn that the acreage planted to Sea Island cotton was considerably increased owing to fair prospects of a remunerative price. Unfortunately, a wet season proved inimical to the cotton crop. Yields were low and expenses increased by the constant need of dusting with Paris green to counteract frequent and intensive attacks by the cotton worm. Pink Bollworm attack appeared early, and no second picking was possible, in consequence the yield was low. The cotton grown by peasants was financed and dealt with through the Antigua Cotton Growers' Association —a private concern which does not derive any pecuniary benefit from its working, but which safeguards the interests of small growers by eliminating speculators and guaranteeing a second payment on a *pro rata* basis. During the season under review the Agricultural Department was relieved of this work (which was formerly carried on at the Botanic Station), and, instead, loans were made to the Antigua Cotton Factory to purchase peasants' cotton at a fixed rate, the Association to decide and distribute any subsequent bonus after marketing it to the best advantage. This has proved a very satisfactory innovation.

372. *Cotton Experiments in Montserrat.* (Extract from *Rpt. of the Agr. Dpt.*, 1926-27, p. 3.) "The area apportioned for cotton breeding plots was somewhat increased during the season under review. Apart from the usual cotton breeding work, which was again chiefly concerned with comparative tests of re-selections from the Heaton strain of cotton isolated in 1918, some plots of cotton were grown from seed of the Heaton strain which was last controlled by self-fertilization in 1924-25. This had for its object the following up of the strain, when planted out under estate conditions, with the view of ascertaining and spotting whether any aberrants in the type would crop up, and if so in what proportion.

"For the purpose, a very prolific type of the variety Heaton 39–12—the parent of which was last self-fertilized in 1924—was tried out. In 1925 this seed was planted in the station's breeding plot, and in 1926 a quarter-acre was planted with the seed from the 1925 plot. This latter plot was carefully kept under the observation of the Curator and staff, and each plant was thoroughly scrutinized throughout its entire life-time. As a result, not a single aberrant plant could be spotted. The plot (one quarter-acre in size) gave a calculated yield of 322 lb. of lint per acre. The lint was submitted to brokers in Manchester, who reported as follows: 'Very clean and bright; staple, fine and strong, regular and free from nep. This is a very desirable type. Valued at 29d. per lb.'

"In 1927 this same strain—now in its third year, removed from self-fertilization control—was again planted, and in no case was any roguing discovered. The plants showed exceptional vigour and bearing qualities. From a 0·44 acre plot 1,110 lbs. of seed cotton were obtained. At the time of writing this had not been ginned. The results obtained from this following up of the characteristics maintained by the cotton breeding plot seed at the Station over a period of three years are most encouraging, and growers cultivating this type of cotton are urgently requested to keep it up to the standard arrived at at the Station.

"It may be of interest to follow up the pedigree of this specially vigorous strain. The last year that this variety was self-fertilized was in 1924, when the three plants from which the strain emanates were classified as follows:

H. 39–12–27–5–20–19 No. 19.
H. 39–12–27–9–8–22 No. 29.
H. 39–12–27–9–8–22 No. 10.

"The three types mentioned are lineal descendants of H. 39–12–27 of the 1920 breeding plot, and a comparison of the values of the parent plant H. 39–12–27 of 1920 with that of the present H. 39–12 strain unfertilized for the past three years may be of interest:

| | *Lint Length. Mm.* | *Lint Index. Grms.* | *Seed Weight. Grms.* | *Per Cent. Lint.* |
|---|---|---|---|---|
| Parent Value of H. 39–12 of 1920 | 49·8 | 5·35 | 12·78 | 29·5 |
| Unselfed H. 39–12 of 1927 .. | 50·1 | 5·60 | 12·70 | 30·8 |

"These figures show a remarkable similarity, and apart from the usual fluctuations consequent on variations of soil and climate, the comparison proves very clearly the purity of this type of the Heaton strain."

**373.** *Cotton Production in Montserrat.* (Abstr. from the *Rpt. of the Agr. Dpt.*, 1926-27, recently received.) The actual production of lint in Montserrat for the season under review was 600,217 lbs., representing an average return of 214 lbs. of lint per acre, which constitutes the greatest annual production since the inception of the industry. A point worthy of note in this year of record production is the more general application of cotton seed meal as a fertilizer to cotton fields. There has been decidedly positive co-relation between increased production and the use of cotton seed meal this year, and there is every reason to expect that the beneficial results derived will encourage its further use as a fertilizer.

Practically the entire crop was sold locally to the agents of the Fine Cotton Spinners' and Doublers' Association, Manchester, who reported on the quality of the cotton as follows: "We find that the quality of cotton is good, and the staple better than usual."

**374.** *Cotton Position in St. Vincent.* (Abstr. from *West India Comm. Circ.*, xliii., 770, 1928, p. 136.) Seeking a better market for Sea Island cotton, leading planters have shipped about fifty bales to the United States. The Government Factory has also made shipments, and in all seventy-two bales have been exported. Dealing with the cotton situation in a leading article, the "Sentry" says: "Instead of a further restricted area to be excluded from cotton cultivation, as suggested by the Agricultural Department, the next season may find the crop much increased and, perhaps, the largest ever reaped. In spite of the many drawbacks which accompany the industry, there is no produce that the peasants can grow to replace cotton as being more profitable and reliable. All the other vegetable products are even more fitful and quickly affected by over-production. We are not without hope that later in the year the Sea Island cotton will find an easy market at a fair price, as it will be much used in the manufacture of artificial silk and for making stockings. With prospects of finding another market and another purpose for the cotton, planters should not further reduce the planting acreage as the chances seem more favourable for a good market than last year."

**375.** ST. VINCENT. *Cotton Report.* A note received from the Superintendent of Agriculture is to the effect that the return per acre for the 1927-28 cotton crop will be indifferent. Soft rot (*Phytopthora*) of bolls was very common and large numbers of bolls rotted; Stainers (*Dysdercus*) also appeared in the cotton fields towards the end of the season.

## *COTTON IN THE UNITED STATES.*

**376.** America. Cotton in Texas (Abstr. from *Text. Rec.*, xlv., **539**, 1928, p. 87.) It is stated that concern is developing over the steady decline in the yield per acre in the state of Texas, where last year it required approximately four acres to produce one bale.

**377.** Cotton Growing in Texas: A Declining Industry? By J. A. Todd. (Abstr. from *Int. Cot. Bull.*, vi., **22**, 1928, p. 268.) It would appear that the average yield of cotton per acre in Texas has declined since about 1894, compared with that of the United States as a whole. Possible causes may be indicated as follows:

(1) Frequent droughty years, alternating with years of excessive rainfall in harvest season.

(2) Pursuing cotton cultivation too far west into areas where rainfall is normally insufficient.

(3) Exhaustion of soil due to continuous cultivation of cotton without rotations, non-use of fertilizers, lack of mixed cropping, cattle, etc.

(4) Insect pests, especially boll weevil, and plant diseases, such as root-rot.

**378.** Fourteen Bales of Cotton on Five Acres. (Abstr. from the *Int. Cot. Bull.*, vi., **22**, 1928, p. 225.) The competition organized by the *Dallas News*, " More Cotton on Fewer Acres," has again been won by a previous winner, Mr. J. W. McFarlane, of Palestine, Texas. He produced 6,922 lbs. of lint on five acres of unirrigated land, or approximately fourteen bales. The cotton planted was the " Wacona " variety, with a staple of $1\frac{1}{8}$ to $1\frac{3}{16}$ inches. The grade was strict middling. He wins $1,500.

The staple prize of $1,000 was awarded to a tenant farmer in Smith County, who produced 6,055 lbs. of lint of a staple of 1 to $1\frac{1}{8}$ inches.

The gross income prize of $1,000 was awarded to a negro farmer, also of Smith County, whose five acres yielded 5,300 lbs. of lint with a staple of $\frac{7}{8}$ to 1 inch.

**379.** Varieties of Cotton in the Red Prairies of North-West Texas. By J. R. Quinby. (*Bull. No.* 366, 1927, *Texas Agr. Exp. Station.*)

**380.** Varieties of Cotton for East Central Texas. By D. T. Killough and G. T. McNess. (*Bull.* No. 369, 1927, *Texas Agr. Exp. Station.*) In addition to the experiments carried out to determine the varieties of cotton best suited to this section of the State, studies were made to determine what characters in cotton have the more relation to the value of the crop. The five characters studied were size of boll, yield of lint, length of lint, percentage of lint, and earliness. In these correlation studies, the higher percentages of lint, larger bolls, and higher yields of lint appeared to be associated. Increases in the length of lint were accompanied by decreases in yield and by decreases in the percentage of lint. Earliness did not seem to be closely associated with any of the other characters, although the relatively early varieties were the ones that made the high yields.

**381.** Commercial Fertilizers in 1926-27 and their Use. By G. S. Fraps and S. E. Asbury. (*Bull.* No. 368, 1927, *Texas Agr. Exp. Station.*)

**382.** Field Crops Experiments in Arkansas. (*Ark. Sta. Bull.*, 221, 1927. Abstr. from *Exp. Sta. Rec.*, 58, **4**, 1928, p. 321.) Continuous pedigree selection during ten generations with cotton having seed with high and low oil and high and low protein contents showed that with an increase in protein there was a corresponding decrease in oil, and with an increase in oil came a decrease in protein. The extreme divergence in the current analysis was evidently partly due to the potentialities existing in the original plants as well as the result of selection. Co-operative fertilizer experiments with cotton suggested that 400 lbs. of a standard mixed fertilizer is practical for average conditions in the State. Although nitrogen and phosphorus are most needed, a complete fertilizer is generally satisfactory and profitable. Building the cotton bed on the fertilizer generally gave better yields than when the fertilizer was applied after bedding. Formulas and rates of application for fertilizer were compared in three localities.

**383. Cotton Grades and Staples in Georgia for Crop of 1927.** (Abstr. from *Press Bull.* No. 275, *Dpt. of Agron. Exp. Sta., Ga.*, 1928.) The Georgia Experiment Station has collected information upon the length of staple of the Georgia crop, and gives the following table:

| *Length of Staple.* | *Percentage of Total Crop*, 1927. |
|---|---|
| $\frac{13}{16}$ inch and under .. .. .. .. | 2·4 |
| $\frac{7}{8}$ inch .. .. .. .. .. | 77·9 |
| $\frac{15}{16}$ inch .. .. .. .. .. | 15·6 |
| 1 and under $1\frac{1}{32}$ inches .. .. .. | 2·6 |
| $1\frac{1}{16}$ and $1\frac{3}{32}$ inches .. .. .. .. | 0·6 |
| $1\frac{1}{8}$ and $1\frac{5}{32}$ inches .. .. .. .. | 0·2 |
| $1\frac{3}{16}$ and $1\frac{7}{32}$ inches .. .. .. .. | 0·3 |
| $1\frac{1}{4}$ inches and over .. .. .. .. | 0·4 |

Most mills in this country and in Europe demand a cotton $\frac{15}{16}$ inch in length or longer. By growing a $\frac{7}{8}$ inch cotton, the Georgia farmer is competing with the cheap Oriental labour of India that produces the shorter staple.

**384. Field Crops Investigations in Mississippi, 1926.** By J. F. O'Kelly *et al.* (*Miss. Sta. Rpt.*, 1926. Abstr. from *Exp. Sta. Rec.*, 58, 1, 1928, p. 31.) Some evidence of crossing over was observed in $F_1$ material from a cross between a cotton variety with medium length and percentage of lint, and one with long staple and low lint percentage. $F_1$ material from a cross between a fuzzless and lintless type and a type with excess fuzz and normal percentage, showed complete dominance of the fuzzless and lintless characters. The $F_2$ from a cross between long and short types appeared to segregate into one long, two medium, and one short. In the $F_2$ from crosses between wilt susceptible and wilt resistant types, the plants lacking the factor for resistance appeared to be eliminated by the fungus.

Fertilizer tests with cotton in the lime belt showed considerable profit from the use of acid phosphate and potash in addition to nitrogen.

**385. Research Work with Cotton.** (Abstr. from the "Fortieth Ann. Rpt. of the South Carolina Exp. Sta." for the year ended June 30, 1927.) Accounts are given in the Report of time of planting, spacing, and variety experiments, cotton fruiting studies, investigations of the biology and control of the Cotton Flea Hopper, physiological work with cotton, and cotton marketing investigations.

**386. Treatment of Cotton Seed.** (Abstr. from the *Fortieth Ann. Rpt. of the South Carolina Exp. Sta.*, 1927, p. 22.) "The seed treatment test has been continued as in former years. The need for earliness is clearly recognized, and one way of securing this earliness is through the planting of seed delinted with sulphuric acid. Germination is hastened by this method of treatment, with an earlier stand as the result. Complete results from the seed treatment plots for 1927 are not available at this time, but on October 7 the plots planted with sulphuric acid delinted seed had produced a yield of 851 lbs. of seed cotton per acre, as compared with 762 lbs. of seed cotton per acre for seed delinted by machinery. Untreated seed planted under similar conditions had at the same date produced but 658 lbs. of seed cotton per acre. The practice of rolling cotton seed in nitrate of soda or ashes prior to planting is often believed to have an effect similar to treating the seed so as to remove the lint. As a rule, however, the yield from such treatment is not as great as that from untreated seed. Such results are indicated by the picking to October 7 this year. At this date those plots from seed so treated had produced but 552 lbs. of seed cotton per acre, or almost exactly 300 lbs. less than from the sulphuric-acid-treated seed."

387. ROOT DEVELOPMENT OF COTTON ON CECIL SANDY LOAM DURING 1926. By G. H. Collings and J. D. Warner. (*J. Amer. Soc. Agron.*, 19, 1927, No. 9, pp. 839-42. Abstr. from *Exp. Sta. Rec.*, 58, 2, 1928, p. 132.) Observations on the root systems of Cleveland cotton plants growing under normal field conditions at the South Carolina Experiment Station on Cecil sandy loam in 1926, a year with a very dry spring and summer, showed the development of the root systems of plants of the same age and size to be very uniform. The small extent to which the soil was occupied by roots was noteworthy. The greater portion of the development of the root system was confined to the surface 8 inches of soil, although many roots of mature plants reached a 1-foot depth. The greatest depth reached by any root was 2 feet. Very few roots of mature plants extended in a lateral direction over 2 feet from the centre of the plant. Greater root development in the neighbourhood of previously applied fertilizer was not observed, and the root development above the fertilizer was slight.

388. THE GOVERNMENT COTTON CROP REPORTING SYSTEM. By W. F. Callander. (*Int. Cot. Bull.*, vi., 22, 1928, p. 237.)

389. TEXTILE RESEARCH ORGANIZATIONS, U.S.A. DESCRIPTION. (*Text. World*, 1928, 73, 696-697 and 867. Abstr. from *Summ. of Curr. Lit.*, viii., 7, 1928, M. 9.) A list of research and studies of technical problems carried out by various associations, schools, and other organizations in America during 1927, together with suggested future work. Illustrations are given of an apparatus for testing the permeability of aircraft fabric to air, and a tester for measuring the resistance of rope yarns to bending, both ascribed to the Bureau of Standards.

390. COTTON AND ITS MARKETING. By F. J. Cavanaugh. (Abstr. from *Int. Cot. Bull.*, vi., 22, 1928, p. 270.) Deals with the subject under the following heads: Mill Consumption of various kinds of cotton throughout the world; Futures as Hedges; "Basis;" The Spot Market; The Co-operatives; The Shipper; Spinners' Markets.

391. COTTON MARKETING IN U.S.A. By C. H. Clark. (*Text. World*, 1928, 73, 699-704, 867. Abstr. from *Summ. of Curr. Lit.*, viii., 7, 1928, M. 9.) The author criticizes inefficient methods of buying. The faults of buying "on description" are described, and it is shown that buying on type supplies a definite standard for trading which is far superior. Taking up cotton in the South presupposes buying against mill types, and its advantage lies in the fact that it is a final transaction eliminating rejections and causes of friction between buyer and seller. It requires the services of an expert, and for that reason is limited to large mills, or groups of small mills, using not less than 50,000 bales annually. As the cost of cotton and other raw materials averages about 50 per cent. of the cost of the finished product, selection and buying should receive more attention. It is suggested that every mill should keep departmental accounts for cotton and other raw materials, and make a profit and loss statement available to stockholders, and the selection of cotton should be made a responsibility of the mill management.

392. COTTON BAGGING. (Abstr. from *Text. Rec.*, xlv., 539, 1928, p. 87.) Nine bales of cotton covered with coarse cotton cloth instead of jute bagging have been placed in the basement of the Senate Office Building in Washington as a

demonstration that cotton covered bales stand rough handling better than do those covered with the customary burlap. These bales were taken from a lot of 120 which were baled at Hendersonville, N.C., sent to Norfolk, Va., and there compressed. They were then shipped to Bremen, Germany, and there warehoused. They were later reshipped to Philadelphia, and then to Washington, thus being subjected to about twice the handling which baled cotton is ordinarily caused to undergo. The Cotton Products Extension Committee of South Carolina has made public a statement by the chief engineer of the New York Board of Water Supply to the effect that 1,020,719 dols. were saved on the construction of the Catskill waterworks by the use of cotton bags in the transportation of cement.

393. WORKING HOURS IN COTTON MILLS, U.S.A. (*Int. Cott. Bull.*, vi., 23, 1928, p. 533.)

## *COTTON IN EGYPT.*

394. EGYPT. THE LAKE PLATEAU BASIN OF THE NILE. Pt. II. By H. E. Hurst. (*Phy. Dpt. Paper*, No. 23, 1927. Obtainable from Govt. Pubns. Off., Min. of Finance, Dawawin P.O. Cairo. Price P.T. 10.) (*Cf.* Abs. 201, vol. iii.)

395. THE COTTON CROP. (Abstr. from *Mnthly. Jour. of Br. Cham. of Comm., Egypt*, xv., 4, 1928, p. 55.) This year's crop is irregular for Sakellaridis. The best cotton is fully equal to, or better than, that of last year, but there is a large proportion of short wasty cotton due to the excessive heat during the summer. Pilion cotton has also suffered from the same cause, and is inferior to last season. In Upper Egypt, the most southerly cotton is lacking in staple, the quality elsewhere being fairly good. Owing to shortage of labour, most of the Upper Egypt crop has suffered from bad picking.

396. IMPROVED EGYPTIAN COTTONS. PRODUCTION. (*Cotton* [Manchester], 1928, 32, No. 1613, p. 6. Abstr. from *Summ. of Curr. Lit.*, viii., 8, 1928, E. 23.) The Ministry of Agriculture, El Giza, has forwarded to the Manchester Cotton Association four bales of Egyptian cotton of the following varieties: *Sakel Domains*: this is the standard Sakel of Egypt as grown by the State Domains Administration. The seed from the Domains is grown under control by the Government, and about 40,000 bales direct from this stock are produced every year. The seed goes to the ordinary cultivator. *Sakel* 310: An improved type which has given better spinning results than Sakel Domains, and the same yield. About 1,000 bales will be grown on the State Domains in 1928 and its seed distributed by the Government. The total crop in 1928 will be about 5,000 bales. *New Ashmouni*: The new type of Uppers with which the Egyptian Government proposes to displace the Uppers at present grown, as fast as it can be propagated. The crop in 1928 should be about 1,000 bales. *Giza* 3: A longer staple Uppers which appears to do very well in the south of Upper Egypt, and may be extensively propagated, in which case it will be given a commercial name. The crop in 1928 should be about 400 bales. The consignment is intended to show spinners and merchants the progress being made by the Egyptian Ministry of Agriculture in its work to raise the standard of all Egyptian cotton, and samples can be supplied on request. [*Cf.* above, p. 242.]

## *COTTON IN FOREIGN COUNTRIES.*

397. ARGENTINE. COTTON CROP. (Abstr. from *Int. Cott. Bull.*, vi., 23, 1928, p. 431.) The condition of the cotton crop is reported as highly satisfactory, and the yield is estimated at about 154,000 bales.

398. BELGIUM. THE COTTON INDUSTRY. (Abstr. from *Commercial Oldham*, ii., 8, 1928, p 10.) In 1917 the Belgians founded and developed a co-operative society which they called "La Textile." It was confronted at the outset with

formidable tasks. The mills had been damaged and plundered; their owners had no guarantee to offer except their record of former activity and energy. Still, the society set to work vigorously, and with a rapidity which surpassed the most sanguine hopes, the mills were restored to working order. The great difficulties of credit were overcome, and within a year of the signing of the Armistice, 1,000,000 spindles were at work, 80 per cent. of the number in pre-War days.

The society arranged almost everything. It re-grouped the mills, decided which class of counts was most suitable for each of them—thus reducing costs—bought the raw material, acted as salesman of the products, collected and sold all waste, conducted foreign trade, and found the largeness of the scale on which it worked under the new conditions of considerable help in extending the field of its operations. So successful did the combination become that within it was formed another combination. Eight mills, containing 260,000 spindles—one-sixth of the whole of the spindles in the country—banded themselves into a company called the "Union Cotonnière," and won more success in the specialization of mills and the further reduction of costs.

**399.** Bolivia's First Cotton Mill. (Abstr. from *Int. Cott. Bull.*, vi., 23, 1928, p. 533.) Bolivia's first cotton-spinning and weaving mill is now being erected at La Paz. The mill is to contain 6,000 spindles and 200 looms, although it is intended to increase the looms to 500 should the venture prove a success. It is being financed by United States and South American capital, and managed by American cotton-mill men. All the machinery is being supplied by American textile machinists.

**400.** Brazil. Cotton Cultivation. (Abstr. from *Int. Cot. Bull.*, vi., 22, 1928, p. 297.) Reports from Brazil appear to indicate that this year's cotton crop will be as large, if not larger, than last year's crop. Plants and bolls are said to be well developed, and quality promises to be exceptional.

**401.** Textiles in Brazil. By P. F. Martin. (*Text. Rec.*, xlv., 537, 1927, p. 46.)

**402.** Brazil. Duties on Imported Cotton Textiles. (Abstr. from *Commercial Oldham*, ii., 8, 1928, p. 17.) Deals with the protest of the British Chamber of Commerce in Brazil against the proposed increase of the duties on cotton.

**403.** Brazil. The Textile Industry. (Abstr. from *Cotton*, xi., 2, 1928.) In 1926 Brazil had 329 cotton mills, with 2,528,611 spindles, and 75,631 looms, compared with 244 mills with 2,163,340 spindles and 65,651 looms in 1924. Cotton consumption, as reported by the mills, increased from 80,530,000 kilos (371,409 bales of 478 lbs. each) in 1924 to 95,321,000 kilos (439,626 bales) in 1926. The production of cotton cloth amounted to 755,572,000 yards in 1926, compared with 733,344,000 in 1925, and 696,572,000 in 1924. The number of operatives increased from 110,119 in 1924 to 124,619 in 1926.

**404.** China. Production and Consumption of Cotton. (Abstr. from *Text. Rec.*, xlv., 538, 1928, p. 67.) According to a report by the Chinese Cotton Mill-owners' Association, about 3,706,000 spindles are installed in all the cotton mills in China.

**405.** Cotton in Cilicia. (*Int. Cot. Bull.*, vi., 22, 1928, p. 298.)

**406.** We have received from the Association Cotonnière Coloniale a copy of Bulletin No. 82, giving useful information in connection with cotton-growing in the French Colonies.

**407.** La Production Cotonnière des Territoires Africains sous Mandat. (Abstr. from *Coton et Culture Cotonnière*, ii., 3, 1927, p. 104.) Climate and soil in Togo appear to be suitable for cotton, and Togo Sea Island is quite acclimatized.

Production in 1927 was 1,600 tons. Local varieties are cultivated in Cameroon, which now exports a small quantity of cotton.

**408.** THE SALIENT FEATURES OF THE COTTON SPINNING INDUSTRY OF JAPAN. By T. Kawasaki. (*Int. Cot. Bull.*, vi., 22, 1928, p. 321.)

**409.** COTTON CULTIVATION IN PARAGUAY. (*Int. Cot. Bull.*, vi., 22, 1928, p. 306.)

**410.** RUSSIA. QUESTION OF COTTON ECONOMICS. A collection of articles on raw cotton problems. (Abstr. from *Khlopkovoie Deilo* Book Series, vol. v., Moscow, 1927.) This journal contains various articles in Russian, with English résumés, abstracts of which are given here.

(1) *Investigation on the Cost of Production of Raw Cotton.* By A. V. Chaianov. The work is based upon an examination of the accounts of forty-five farms in Ferghana (Central Asia) in 1917, and eighty-four in 1923-24. The figures of cost of production varied greatly, the highest being ten times the lowest. The prime cost curves derived from the figures, however, agreed well enough, and a mathematical treatment gave an average cost of production varying from 2·69 to 0·30 in 1917 to 4·51 to 0·20 in 1923-24 (unit ?). The cost was correlated with the yield, the amount of water used, and the size of the farm.

(2) *Nutrition of Ferghana Cotton-Growing Population.* By W. Uferef. The nutrition remains much as in pre-War days, somewhat poor in proteins and fats, rich in carbohydrates.

(3) *Cotton Farming in Ferghana According to the 1924 Survey.* By B. Solovief. Land and labour factors are considered, as well as capitalization and income.

**411.** COTTON MANUFACTURING IN SOUTH AMERICA. (*Int. Cot. Bull.*, vi., 22, 1928, p. 315.)

**412.** SPAIN. EL CULTIVO DEL ALGODON EN ESPAÑA. By E. Fernandez. (Abstr. from *Int. Rev. of the Sci. and Pract. of Agr.*, Rome, xviii., 11, 1927, T. 665.) The author has for many years carried out experiments in cotton-growing with and without irrigation in the "Granja Escuela de Agricultura" of Badajoz; in 1925 he obtained in the non-irrigated plot 1,390 kg. per hectare of unginned cotton.

**413.** COTTON GROWING IN SPAIN. (Abstr. from *Times Trade Supplement*, May 19, 1928.) Cotton-growing is progressing in Spain, although slowly. The best results so far have been obtained in Andalusia, but the crop is still being grown also in Estremadura and even as far north as Tarragona in Catalonia. About 3,500,000 lbs. of cotton were ginned in 1927. Growing is encouraged by premiums, credit facilities, free advice as to methods of cultivation, etc.

**414.** COTTON-GROWING IN SPAIN. (*Int. Cott. Bull.*, vi., 23, 1928, p. 432.)

## *CULTIVATION AND MACHINERY: IRRIGATION, ETC.*

**415.** THE EVOLUTION AND CLASSIFICATION OF SOILS. By Dr. E. Ramann. Translated by Dr. C. L. Whittles. (Pp. xii + 127. Cambridge: W. Heffer and Sons, Ltd., 1928. 7s. 6d. net.) Three systems of soil classification have been developed in the past. These may be called (*a*) the physical system, based on soil texture; (*b*) the geological system, based on the geological formation from which the soil has been derived; and (*c*) the chemical system, based on chemical composition. None of these systems has added greatly to our fundamental knowledge of the soil or provided data upon which a forecast could be made of the behaviour of unknown soils under cultivation. From the purely scientific aspect, therefore, they appear to be unsound and, from the practical point of view, they have been of little use. The study of the factors determining the formation of soils is now recognized as the natural starting-point of any system of soil classification. The initial investigations on the factors determining the formation of soils were carried out by the Russian workers, Dokutschajeff, Sibirceff, and Glinka, but the results were not accessible, owing to language difficulties, to soil scientists in other countries. The publication by Dr. Ramann, in German, of the results of the investigations of the Russian Soil School was a definite step in the development of soil science and one of the main factors leading to international co-operation in the study of soils. The translation of Dr. Ramann's book has rendered the work readily accessible to the British workers in this subject.

A system of soil classification resting on a climatic basis has not the importance in Great Britain that it has in other countries. The soils of Great Britain are immature, endodynamomorphic, and hence do not exhibit the variety shown by those of other countries. The recommendations of the recent Imperial Agricultural Conference have, however, placed an entirely different aspect on the question. The great variations in climatic conditions to be found in the British Empire lead to as great variations in the conditions of soil formation, and hence to a large number of soil types. The classification of soils on a climatic basis assumes, therefore, a peculiar importance in connection with the practical problems of land development in the Empire, and the appearance of this translation is most opportune.

The preface to the German Edition is dated 1917. Developments have taken place since this date which render necessary the revision of some portions of the book. This is particularly the case in connection with the discussion of alkaline soils (pp. 99-104). Reference is frequently made to " alkaline carbonates " in the soil, and to the conversion of these to " bicarbonates." Alkaline carbonates do not exist in alkaline soils. The phenomena of soil alkalinity can be completely explained by the hydrolysis of sodium-clay, the alkaline soil solution containing sodium hydroxide, and not sodium carbonate. Again, as alkaline soils are impermeable, it is difficult to see how the suggested transference of sodium " carbonate " from the surface soil to the subsoil can take place. It is further suggested (p. 103) that the subsoil atmosphere contains carbon dioxide. This is now known to be incorrect. In the preface Dr. Ramann pleads for the recognition of the study of the soil as a science. So long as terms such as " soda " appear in the literature, it is doubtful whether it will be recognized as a science by chemists.

It is suggested (p. 3) that the general effect of a vegetative covering is the same as would be produced if the soil were removed to a cooler and moister climate. This statement is unlikely to receive general acceptance, as it is well known that a vegetative covering has a drying effect on the lower soil layers and restricts water circulation in the soil. The classification of the soil water (p. 12), and the deductions made from it, need modification as the result of recent work on this subject.

The statement (pp. 13-14) that a fine-grained Tertiary sand known as " Flinz " is " from its very nature not impermeable " could have been supported by experimental evidence. Impermeable fine-grained " sands " are readily produced as the result of base exchange with sodium chloride solutions, and the subsequent hydrolysis of the base exchange product in fresh water. Examples of naturally occurring impermeable " sands " are numerous in Egypt.

The translator has had a difficult task in finding suitable English equivalents for the various soil types, and he is to be congratulated on the result of his efforts. It is, however, doubtful whether " Warp Soils " is a good substitute for " Alluvial Soils." In the discussion (p. 83) it is shown that the production of these soils depends on the nature and composition of the districts drained by the rivers. Warping, as understood in this country, is essentially the deposition of a marine silt, and does not depend on the composition of the districts drained by the rivers. It would have been better to have retained the term "Alluvial Soils" and to have discussed "Warp Soils" as a subdivision of saline soils.

On page 3 it is stated that "at 10 to 20 cm. the yearly variations (in soil temperature) cease to attain measurable values." This is obviously an error that has escaped attention in reading the proofs.

This translation of Dr. Ramann's book will be appreciated by all who have studied soil problems under a wide range of climatic conditions. The development of the Colonies and Dependencies must be mainly agricultural. A sound knowledge of the soil is, therefore, an essential to success. The book will be of the greatest value to those taking part in the solution of the agricultural problems connected with this development.—[E. McK. T.]

416. THE MECHANICAL ANALYSIS OF TROPICAL SOILS. By J. Charlton. (*Bull.* No. 172, 1927, *Agr. Res., Inst. Pusa.* Obtainable from Govt. of India Central Pubns. Branch, 3, Govt. Place West, Calcutta. Price As. 3, or 4d.)

417. FIRST COMMISSION. SOIL MECHANICS AND PHYSICS. By B. A. Keen. (Reprinted from *Soil Science*, xxv., 1, 1928.) A critical survey of the present position of soil physics and a forecast of possible future activities, written at the conclusion of the First International Congress of Soil Science.

418. SOIL TEMPERATURE STUDIES WITH COTTON. By A. F. Camp and M. N. Walker. (Abstr. from *Bull.* No. 189, 1927, *Univ. of Florida Agr. Exp. Sta.*, Gainesville, Florida.) A soil temperature tank, based on an internally balanced system, and which is believed to be more economical than the single unit type, is described and its efficiency discussed.

Experiments on the germination of cotton at various soil temperatures showed an optimum of 33° to 34° C., and no germination at 40° C. No germination was obtained at 14° C. or below, but under more nearly sterile conditions it is believed that germination might be obtained. Between 15° and 35° C. the rate of germination agrees very well with the Van't Hoff rule.

Measurements of the growth of cotton seedlings indicated that under the conditions of the experiments some environmental factor other than temperature largely limited their growth between approximately 20° to 35° C., temperature being a limiting factor only above or below that range.

Outdoor soil temperature records for the last two years indicate that the usual planting period (March 25 to April 5) is about as early as strong germination of cotton seed can be expected.

419. AN ACCOUNT OF SOME MOISTURE INVESTIGATIONS CARRIED OUT AT THE GEZIRA RESEARCH FARM. By Dr. H. Greene. (A paper read and discussed at a meeting of research workers engaged in Cotton Research in the Sudan.) Deals with the clay content of the soil; the physical relations between soil and water; the effect of flooding; distribution of water in terrassed land; moisture content of fallow land; root development; the penetration of irrigation water.

420. SULPHUR AS A FERTILIZER. (Abstr. from the *Rpt. of the Govt. Chemist* for the year 1927, p. 23. Wellcome Trop. Res. Labs., Khartoum, Sudan.) The experiment of manuring cotton with sulphur was repeated this year on Hosh 6, feddan 7, five one-tenth acre plots being used, with another five as controls. The results were as follows:

| | *Sulphur Plots.* | *Blank Plots.* |
|---|---|---|
| pH before the trial .. .. .. | 8·65 | 8·64 |
| pH after the trial .. .. .. | 8·33 | 8·65 |
| Yield lbs. seed cotton per acre .. .. | 404 | 380 |

The increase of yield of five per cent. is even less than that (eight per cent.) of last year, and is not encouraging as far as immediate return is concerned.

**421. DECOMPOSITION OF COTTONSEED MEAL IN THE SOIL.** (Abstr. from Publication No. 2. Experimental Res. Inst. of Irrigation, Tashkent, 1927.) (In Russian.) We quote the following summary, which is given in English:

"1. The cottonseed meal as to its composition is a substance rapidly decomposable in the soil; the energy of decomposition during the experiment is decreasing probably in consequence of the presence of some constituents that are decomposing more slowly.

"2. The process of the ammonification of N-compounds starts immediately after inserting the cottonseed meal into the soil. The quantity of $NH_3$ formed as a rule increases according to the dosages.

"3. The beginning of the process of nitrification depends on the amount of cottonseed meal inserted: the less the dosage the sooner starts the process. The dosages from 0·5 to 2 per cent. give a steadily increasing amount of nitrates. A dosage of 5 per cent. intensively oppresses, and that of 10 per cent. entirely annihilates the process of nitrification. In the last case the mineralization of N-compounds is ceased with the formation of $NH_3$ only.

"4. The disappearance of nitrates at the insertion of the cottonseed meal into the soil during the first days of experiment is in some extent due to their partitive transformation into organic form of nitrogen (into proteinous compound of the bodies of bacteria and fungi), partly to their entire loss effected by denitrification (the rôle of strong denitrificators in the process of decomposition of the cottonseed meal); in the first case we have only a temporary transformation of nitrogen into forms inaccessible for the plant, in the second its entire loss."

**422. RECENT STUDIES IN PLANT PHYSIOLOGY AND PATHOLOGY.** By R. E. Massey. (A paper read at a meeting of research workers engaged in Cotton Research in the Sudan.) Discusses the effect of light and temperature on the growth of plants. It is stated that there is much evidence that the manner of growth in plants is directly related to the relative amounts of carbohydrate and nitrogen in the tissues. The question of the acidity of the plant tissues is also studied. The paper is furnished with excellent graphs.

**423. THE ROTATION OF CROPS.** By L. A. Brunton. (*Proc. of Agr. Soc. of Trinidad and Tobago*, xxvii., 10, 1927, p. 422.)

**424. CROP ROTATION IN THE BLACKLAND REGION OF CENTRAL TEXAS.** By E. B. Reynolds and D. T. Killough. (*Bull.* No. 365, 1927, *Texas Agr. Exp. Station.*) It is common knowledge that yields of cotton in the Blackland region of Central Texas are gradually declining. The almost continuous cropping of these soils to cotton year after year without much, if any, effort being made to maintain or increase their productiveness by the use of fertilizers and manures, crop rotations, or the prevention of soil washing, has resulted in a reduction in the productiveness of a region once thought to be inexhaustible in its fertility. The use of fertilizers has not been successful in restoring these soils to their original productiveness. Rotation or changing of crops on the land appears to offer the most promising immediate solution of the problem. Rotation of crops distributes the labour, helps to keep down weeds, controls insect pests and crop diseases, and makes possible the production of feed crops for home use or the production of livestock.

Cotton, corn, wheat, and oats produced larger yields in rotation than when grown continuously on the same land year after year as shown in eleven years of experiments with several rotations at Temple, Texas. Yields of cotton have been doubled; yields of corn increased 87 per cent.; wheat, 55 per cent.; and oats, 17 per cent. by rotations, as compared with continuous cropping. Rotation of crops reduced root rot of cotton from 39·7 to 4·8 per cent.

The crops in the three-year rotation of cotton, corn, and oats, brought the highest comparative net profit per acre, $15·96 annually for a period of six years. Cotton planted on the same land continuously showed an average yearly comparative net profit of $7·33 per acre; corn planted continuously, $2·32 per acre; oats planted continuously, $2·25 per acre; and wheat planted continuously, $2·02 per acre.

425. The Perennial Cultivation of Cotton, with Special Reference to the Cultivation of Ratoons in Egypt. By J. Templeton. (*Tech. and Sci. Serv. Bull.*, No. 75, Min. of Agr., Egypt.) The writer gives a summary of the literature relating to the perennial growth of cotton in Egypt, South America, Australia, North America, etc., and points out that the usual statements as to inferior quality in ratooned cotton, and liability to insect pests, are to a considerable extent *a priori* assertions, passed from one to another, without much experimental evidence to back them. In view of this unsatisfactory state of affairs, experiments have been conducted in Egypt for five years, supplemented by spinning tests in England. The plots compared were somewhat small, but from the general evidence it would appear that ratooning *may* be of considerable advantage. The ratoon crop is about six weeks earlier, and on the whole of better quality and sometimes heavier; in addition, it is stated that a good deal of expense in cultivation is saved in the second year.

The author points out that the above results from experiments carried out in Egypt cannot be held to apply to all countries, and the subject of the perennial cultivation of cotton is worth investigation in all countries where cotton is grown.

426. Results of Cotton Spacing Experiments, with Recommendations. By P. H. Kime. (*Agr. Infmn. Circ.*, No. 10, 1928. North Carolina Agr. Exp. Sta., Raleigh, N.C.) The results of the experiments showed that larger yields were secured from 8 to 12-inch spacings than when hills were farther apart.

427. Cotton Sledding Tests. (Abstr. from *Int. Cot. Bull.*, vi., 22, 1928, p. 235.) In a competition of cotton sleds at Lubbock, Texas, held under the direction of the Superintendent of the Lubbock Agricultural Experimental Station, it was found that the simple finger type of sled, such as is usually put together by the local smith for $10 to $15, harvested a far larger percentage of cotton than any other type.

428. Sledded Cotton. (Abstr. from *Text. Rec.*, xlv., 537, 1927, p. 42.) From this article we quote the following: "Because of the extraneous matter gathered with the cotton, it requires from 2,000 lbs. to 3,000 lbs. of sledded cotton to secure a 500 lb. bale of lint cotton from the gin. The percentage of waste in sledded cotton is about 50 per cent. greater than in picked cotton."

429. Raw Cotton. Marketing. By R. Belshaw. (*Text. Weekly*, 1, 1928, 4-6, 34-36. Abstr. from *Summ. of Curr. Lit.*, viii., 8, 1928, E. 25.) The author discusses grade and staple, the classification of cotton, crop grade fluctuations, the systems on which raw cotton is bought, and the principal markets.

430. Preparation of Cotton for Sale. By H. C. Jefferys. (Abstr. from the *Rhod. Agr. Jour.*, xxv., 3, 1928, p. 275.) Deals with the evils of false packing and the necessity for better classification of cotton in the field and at the ginnery. The article should be read by cotton-growers.

## *DISEASES, PESTS, AND INJURIES, AND THEIR TREATMENT.*

431. Disinfection of Cotton Bales in Vacuum Apparatus. (In Russian.) By V. V. Nikol'skii. (*Khlop. Delo.*, vi., 9-10. Moscow, 1927. Abstr. in *Rev. Appl. Ent.*, xvi., 3, 1928, p. 131.)

432. Entomology in the Southern States. By R. W. Harned. (Abstr. from *J. of Econ. Ent.*, xxi., 1, 1928, p. 59.) A brief résumé of entomology in the eleven south-eastern states, known as the Cotton States, is given, together with a study

of the distribution of entomologists throughout the United States. Among the subjects discussed are: The relation of insects to economic and industrial progress in the Southern States; some of the important entomological achievements in this region; and the confidence that is placed in the entomologists by the public.

433. EIGHT NEW SPECIES OF BRACONIDÆ. By D. S. Wilkinson. (Abstr. from *Bull. of Ent. Res.*, xviii., Pt. I., 1927, p. 33.) Among the species described is *Microbracon kirkpatricki*, sp.n.

434. A CONTRIBUTION TO OUR KNOWLEDGE OF SOUTH INDIAN BRACONIDAE. By T. V. Ramakrishna Ayyar. (*Mems. of Dept. of Agr. in India*, x., 3, 1928.) Includes a description of *Microbracon lefroyi*, Dudgeon and Gough, a parasite of the Cotton Bollworm.

435. ON THE BIOLOGY OF SOME ICHNEUMONIDS OF THE GENUS PANISCUS, SCHRK. By A. M. Vance. (*Ann. Ent. Soc. Amer.*, xx., 3, 1927. Abstr. from *Rev. Appl. Ent.*, xvi., 3, 1928, p. 113.) Observations recorded on the Ichneumonids, *Paniscus spinipes*, Cushm., and *P. geminatus*, Say, var. *sayi*, Cushm., in Virginia in 1924, when about 5 per cent. of the larvæ of the corn earworm *Heliothis obsoleta*, F. (also known as the American Bollworm) in certain localities were attacked by these parasites. The conditions of rearing in the laboratory are explained, and a typical oviposition observation is recorded. Females of both species readily oviposited upon larvæ of *H. obsoleta* in glass cages, the host larva being stung in each case before oviposition occurred. From one to five eggs may be deposited upon one host larva, but apparently never more than one parasite larva survives. Both species paralyze their host by the injection of some toxic substance before ovipositing. Many larvæ are attacked in turn; one female deposited ninety-five eggs upon seventy-eight mature larvæ. Cutworms or army worms placed in the cages were chosen in preference for oviposition. The egg and the method of its attachment are described. The entire larval period of these parasites is spent on, and at the expense of, the host. Almost immediately upon hatching the mouthparts become fastened to the host body, and in this position the parasite larva feeds and grows. During the earlier larval stages of the parasite, the host remains alive in a mature or pre-pupal condition. When the parasite larva reaches maturity, it spins itself a cocoon in which it pupates, but can only do so in a space just large enough to allow of free movement. Both these species of Paniscus reproduce parthenogenetically.

436. COMPARATIVE OBSERVATIONS ON THE PESTS OF COTTON AT ILORIN, NORTHERN NIGERIA. By Owen B. Lean. (Abstr. from the *Sixth Ann. Bull. of the Dpt. of Agr., Nigeria*, 1927, p. 127.) The following four varieties of July sown cotton, grown under plantation conditions at Ilorin, have been studied: Allen, *G. hirsutum* (*var.* Allen's Long Staple); Ishan, *G. vitifolium*; Kabba, probably *G. vitifolium*; and Ilorin, probably identical with "Meko," *G. peruvianum*.

Comparison of native cotton grown on soils with different specific conductivities has given the following results:

1. (*a*) A higher percentage of buds and bolls were shed where the specific conductivity was high.

(*b*) In spite of the increased percentage of bud shedding, a greater number of flowers were produced where the specific conductivity was high.

(*c*) In spite of the increased percentage of boll shedding, a greater number of bolls matured where the specific conductivity was high.

(*d*) As shown by analysis of bolls shed and harvested, bacterial disease caused more damage where the specific conductivity was low. Bollworms appeared also to cause more damage under these conditions, while the cotton stainers were more active where the specific conductivity was high, probably because more stainers were attracted to the plots where most flowers were produced, and the shade cast by the more luxuriant foliage protected the nymphs.

(e) Where the specific conductivity was high the flowering and consequently the bolling was delayed, causing a greater number of bolls to mature after the decrease of the stainer attack, so that the final yields were not only higher but the percentage of clean seed cotton was greater.

2. In all varieties the cotton stainer damaged the greatest number of locks, but on the Allen cotton, at any rate, bollworms probably caused more actual damage, and it seems likely that in years when the crop has failed bollworms have been largely responsible.

3. Kabba cotton yielded a much smaller crop than either the Ishan or Ilorin, but this variety exhibited some characteristics that might make a selected strain of much value.

4. The difference in yield between the Ishan and Ilorin was small, but the Ishan lint was the less stained, and is of higher value.

**437.** DISPERSAL OF THE COTTON BOLL WEEVIL, ANTHONOMUS GRANDIS BOH. By F. A. Fenton. (Abstr. from *Jour. of Agr. Res.*, xxxvi., 2, 1928, p. 135.) Deals with the dispersal of the boll weevil by flight, which is common in the summer months.

**438.** THE PREPARATION OF SPECIAL CALCIUM ARSENATES CONTAINING LESS THAN 40 PER CENT. ARSENIC AS $As_2O_5$, AND THEIR USE AS BOLL WEEVIL POISONS. By H. W. Walker. (Abstr. from *J. of Econ. Ent.*, 21, 1, 1928, p. 166.) A special calcium arsenate prepared by heating precipitated chalk and white arsenic ($As_2O_3$) in the presence of excess air at a temperature of 650° C. for about one hour, and containing only about 20 per cent. arsenic calculated as $As_2O_5$, was found to be equally as effective a boll weevil control as commercial calcium arsenate in extended cage and field tests. The material caused no plant injury.

**439.** THE PREPARATION OF A SPECIAL LIGHT SODIUM FLUOSILICATE AND ITS USE AS A BOLL WEEVIL POISON. By H. W. Walker. (Abstr. from *J. of Econ. Ent.*, xxi., 1, 1928, p. 156.) Two serious objections to the use of commercial sodium fluosilicate as a boll weevil poison are its lack of covering power, due to its comparatively high apparent specific gravity, and its plant toxicity. These have been overcome by incorporating from 10 to 20 per cent. colloidal silica with the sodium fluosilicate during the commercial process of manufacture.

The resulting special light sodium fluosilicate, containing at least 80 per cent. $Na_2SiF_6$, causes no economic plant injury, and is a quicker weevil killer than commercial calcium arsenate. Under certain field conditions, however, it does not adhere to the plant so well as calcium arsenate. This lack of adherence under extremely moist conditions can probably be overcome by the incorporation of a small amount of adhesive during the process of manufacture.

Barium fluosilicate similarly prepared is about as effective as the sodium salt.

**440.** COTTON BOLL WEEVIL DAMAGE DURING 1927. By R. W. Leiby. (Abstr. from *J. of Econ. Ent.*, xxi., 1, 1928, p. 151.) The year 1927 was one of marked injury to cotton by the boll weevil. It was, therefore, thought advisable to compile the estimates of damage in the different states so that the apparent monetary value of the destroyed cotton could be recorded.

The injury to cotton resulted from a successful winter survival of weevils that was above the average, and a fairly favourable season for development. The damage throughout the cotton states was unusually heavy, in spite of a generally favourable cotton-growing season. The worst damage recorded is in Georgia, which reported 40 per cent., or 733,333 bales.

**441.** Oviposition of the Boll Weevil in Relation to Food. By D. Isely. (*J. of Econ. Ent.*, xxi., 1, 1928, p. 152.)

**442.** Entomological Work at the Arkansas Station. (*Ark. Sta. Bul.*, 221, 1927. Abstr. from *Exp. Sta. Rec.*, lviii., 4, 1928, p. 344.) In work with the boll weevil, it was found that the insect preferred the green-leafed Acala cotton (of alternate rows of green and red), only infesting the red-leafed Winesap variety after the green was fully occupied.

**443.** The Pink Bollworm Moth. The Time of Its Emergence. By A. Gallwey. (Abstr. from the *West India Comm. Circ.*, xlii., 760, 1927, p. 461.) At the instance of the Hon. Thomas E. Peters, the suggestion was made recently that steps might be taken to ascertain, if possible, the time of emergence of the moth of the pink bollworm, with a view to fixing a definite planting season for cotton in Antigua, so that, weather permitting, once the periodicity of pink bollworm was established, such attacks could be forestalled by early planting.

Professor Ballou, the Commissioner of Agriculture for the West Indies, has submitted two memoranda embodying details for the carrying out of experiments, and following out his instructions, a cage 10 feet long, 6 feet wide, and 6 feet 6 inches high, with a wing 4 feet by 4 feet, and covered with fine mosquito gauze, has been built for this purpose. It is proposed to place at intervals cotton seed, seed-cotton, and old bolls infested with pink bollworm larvæ in trays in the cage, and to introduce cotton plants, which have been grown in pots or kerosene tins, two weeks after flowering has begun; say, ten such plants on the first day of each month. After three weeks, when the bolls are some four to five weeks old, all bolls are to be examined by slicing, or by separation of the carpels, and the infestation by pink bollworm recorded. These plants will then be removed from the cage and destroyed. Another lot of ten plants in the same condition of flowering will then be placed in the cage and the procedure repeated.

The conclusions that it is hoped that these investigations will lead to are:

(*a*) The degree of infestation in the seed at the end of the cotton season.
(*b*) The natural death-rate of the pink bollworm in stored cotton seed.
(*c*) The time of emergence of the moths from infested seed, week by week, over a period of twenty weeks.

The examination of the moths taken in these counts, checked by the examinations of the double seeds for the presence or absence of larvæ, and the proportion of dead and living larvæ, should give fairly accurate results of the degree of infestation.

These results should give an indication as to the time when cotton in the field is most likely to be attacked. The female moth lives but a short time after emergence, and accordingly if suitable conditions for egg-laying are not available, the moth dies without oviposition.

**444.** Parasites of the Pink Bollworm in Hawaii. By H. F. Willard. (Abstr. from *Tech. Bull.*, No. 19, 1927, U.S. Dpt. of Agr., Washington, D.C.) Summary. The Pink Bollworm (*Pectinophora gossypiella*) has been reared in Hawaii from several species of cotton (*Gossypium* spp.), milo (*Thespesia populnea*), *Hibiscadelphus hualalaiensis*, and *Hibiscus youngianus*. Cultivated cotton is heavily attacked by this moth. One lot of 22 bolls contained an average of 5·1 pink bollworm caterpillars per boll, and the total number of bolls, 8,744, collected during 1918 and 1919, produced an average of 1·5 caterpillars per boll. The seed pods of *T. populnea* are frequently found infested, but the infestation is not heavy. *H. hualalaiensis* and *H. youngianus* are not abundant in Hawaii, and only occasionally are found infested.

*P. gossypiella* is attacked in Hawaii by seven species of parasites as follows: *Chelonus blackburni* Cameron, *Microbracon mellitor* Say (*M. pembertoni* Bridwell), *Pimpla hawaiiensis* Cameron, *Pristomerus hawaiiensis* Ashmead, *Perisierola emigrata* Rohwer, *Chalcis obscurata* Walker, and *Stomatoceras pertorvus* Girault. None of these is a specific parasite of *P. gossypiella*. Each one has been reared from several other species of moths in Hawaii, while *P. hawaiiensis* and *C. obscurata* have been reared from ten and thirteen different hosts respectively. This diversity of hosts is largely responsible for the low degree of control of *P. gossypiella* exerted by these parasites. Only 8·42 per cent. of 12,985 caterpillars, under observation during 1918 and 1919, were parasitized by the combined efforts of the seven species.

*Microbracon mellitor* is considered the most effective parasite of *P. gossypiella* under Hawaiian conditions, because of its general distribution throughout the area under observation, and various factors in its biology. The adult is hardy and able to maintain itself under adverse conditions, and its capacity for oviposition is good. One female deposited 213 eggs before death. The maximum period from the oviposition of the egg to emergence of the adult was sixteen days.

Mating of *Perisierola emigrata* was observed to occur only within the cocoon of the female. The adult female is capable of ovipositing throughout her lifetime, and one female deposited 236 eggs. Parthenogenetic reproduction was observed with this species, but only males were produced. From 1,413 unfertilized eggs under observation, 1,198 males, and no females, were reared.

445. NOTES ON A BRACONID PARASITE OF THE PINK BOLLWORM (PLATYEDRA GOSSYPIELLA SAUND), IN KENYA COLONY. By T. W. Kirkpatrick. (Abstr. from *Bull. of Ent. Res.*, xviii., Pt. I., 1927, p. 47.) Information is given under the following headings: Notes on the life-history of the parasite (*Microbracon Kirkpatricki*); Parasitization of *Platyedra* larvæ in green and open bolls; The longevity of the adult parasite; Parasites kept in cold storage; Experiment on the possibilities of breeding in captivity.

In dealing with the amount of control effected by the parasite, the author states as follows: "No accurate estimation was made of the bollworm population in November or again in February. The impression was, however, formed that it was scarcely if at all greater towards the end of the picking season, possibly even slightly less. Both in November and in February there were probably about 20 to 25 per cent. of the bolls attacked by pink bollworm; except for the parasite, it is more than likely that the percentage of attack would by February have reached 90 to 100 per cent. The percentage of parasitized caterpillars had undoubtedly increased enormously by February.

"It would appear that it would be by no means difficult to import this parasite into other countries where it might be of value. Whether it could ever adapt itself to live in a country where there is a definite winter, which is passed by the pink bollworm as a resting larva, is a matter of conjecture; it would, however, probably be quite easy to breed the parasites artificially during the winter on the resting larvæ in 'double' seeds."

446. HAITIAN COTTON AND THE PINK BOLLWORM. By G. N. Wolcott. (Abstr. from *Bull. of Ent. Res.*, xviii., Part I., 1927, p. 79.) A general account of Haitian cotton, calling attention to its high degree of immunity from bollworm.

447. A METHOD OF GROWING NORMAL PLANTS OF COTTON FOR OBSERVATION AND THE BEHAVIOUR OF BROACH COTTON UNDER THESE CONDITIONS AT SURAT. By R. S. Kasargode. (Abstr. from *Agr. Jour. of India*, xxii., 6, 1927, p. 442.) The growing of cotton plants under permanent cages (to control bollworm) is stated by the author to have resulted in such abnormalities of growth that observations were of little use. The internodes were extremely long, the leaves thin and broad, the stems trailing and weak, and ultimately the plants had to be discarded.

Detailed life-history of the bollworms has shown that the moth is capable of laying eggs only at night, and under no circumstances was it possible to get the moths to lay eggs by daytime. Therefore it was thought necessary to protect the plants at nighttime only. A certain number of plants were caged in the following manner, and were fully exposed to the sun and wind by daytime. Light wooden cages with mosquito netting were utilized to cover the plants by night, the cages being placed on the plants about 5 p.m. in the evening, and removed again at daybreak. The plants grew in the most satisfactory manner, free from bollworm attack throughout the season. In order to protect them from caterpillars crossing over to them from other plants in the vicinity, small tin trenches were slipped over the plants when they were quite young, and the trenches were kept filled with water covered with a thin film of non-volatile oil. The oil would catch any larvæ that might attempt to cross over. Precautions should be taken that when the plants are caged in the evening they should be shaken slightly in order to drive away any bollworm moths that might have settled on the plants by day. Cotton plants protected in this way showed none of the abnormalities mentioned in the case of the plants grown under permanent large cages.

**448.** PINK BOLLWORM IN TEXAS. (Abstr. from *Int. Cott. Bull.*, vi., **23**, 1928, p. 449.) Calling attention to the infestation of apparently new areas in Texas by the Pink Bollworm.

**449.** WEST INDIES. COTTON PESTS IN MONTSERRAT. (Abstr. from the *Rpt. of the Agr. Dpt.*, 1926-27, recently received.) The chief pests attacking cotton during the year under review were the Cotton Leaf-Eating Worm (*Alabama argillacea*), and the Pink Bollworm. The damage done to the crop by the latter insect was insignificant in comparison with that of previous years, owing to the success that attended the co-operative efforts of all cotton-growers to stamp out the pest by the careful and efficient " close season " campaign carried out in the year 1925-26.

**450.** THE JASSID PEST OF COTTON. (Abstr. from *East Afr.*, iv., **189**, 1928, p. 1106.) A review and abstract of the Corporation's recent publication, " Reports Received from Experiment Stations, 1926-27."

**451.** NOTE SUR LE MOYEN DE COMBATTRE LE VER DU COTON PAR L'ARSENIATE DE CHAUX. By E. Aghion. (*Bull. Un. Agric. Egypte*, xxv., **183**, 1927. Abstr. from *Rev. Appl. Ent.*, xvi., **3**, 1928, p. 117.) The injury caused to cotton by *Prodenia litura*, F. (*littoralis*, Boisd.) in Egypt results in general weakening of the plants, and retarding of boll formation, thus exposing the bolls to attack by other pests. Hitherto hand collection has been the only method employed against it. In experiments with calcium arsenate, the dust was applied both in fields where larval injury was already noticeable, and in those where the larvæ had not yet hatched. The applications were made in the morning, so that the calcium arsenate would adhere to the leaves owing to the presence of dew; two applications were made at intervals of fifteen to twenty days, using about 25 lbs. to the acre. About a fortnight after the second treatment, practically no damage was noticed, the plants were healthy, and about 8 to 10 inches taller than those on the untreated plots. The latter showed considerable injury in spite of hand collection.

**452.** SEPTICÆMIA OF THE CUTWORM (*Agrotis Segetum*, SCHIFF). By V. Pospelov. (Abstr. from *Rpts. on Appl. Ent.*, vol. iii., No. 1, State Inst. of Experimental Agronomy, Leningrad, 1927, p. 1.) In Russian, with a long abstract in English. The symptoms of the disease are described. Puncture experiments, as a means of control, were successful in about 50 per cent. of the cases.

**453.** A NOTE ON SOME SOUTH AFRICAN LEPIDOPTERA OF ECONOMIC IMPORTANCE, WITH ESPECIAL REFERENCE TO THE EASTERN TRANSVAAL. By J. S. Taylor. (*Ent. Rec.*, xxxix., **10**, 1927. Abstr. from *Rev. Appl. Ent.*, xvi., **2**, 1928, p. 62.)

*Cosmophila auragoides*, Guen., is probably the most important of the minor pests of cotton in the Eastern Transvaal; it caused considerable damage in 1925-26, but was comparatively scarce in 1926-27, probably owing to the activities of Chalcid and Tachinid parasites. The larvæ feed on the leaves, and pupation occurs in a loose cocoon among the leaves or bracts. *Xanthodes grællsi*, Feisth., also feeds on the leaves, and was more abundant than *C. auragoides* during 1926-27. Pupation occurs in an earthen cocoon in the soil; in the summer the adults emerge after a pupal period of about eighteen days. Hibernation occurs in the larval stage within the cocoon. A Tachinid has been reared from the larvæ. Another Noctuid, *Tarache nitidula*, F., has similar habits. In January, 1927, *Laphygma exigua*, Hb., was found attacking cotton foliage, the larvæ forming webs on the lower surface of the leaves. Pupation occurred in the soil, the adults emerging after about eighteen days. The larvæ were parasitized by a Braconid.

454. UN NOUVEL ENNEMI DU COTONNIER DANS L'AFRIQUE TROPICALE. By A. Théry. (*Bull. Soc. Sci. nat. Maroc.*, vii., 1-3, 1927. Abstr. from *Rev. Appl. Ent.*, xvi., 3, 1928, p. 127.) A revised description and figure of a species of *Anthaxia* found on cotton at Khartoum, and proved to be the well-known Senegalese species, *Anthaxia binotata*, Chevr.

455. *Pyrameis Cardui*, L. AS A PEST OF COTTON. (Preliminary paper, in Russian.) By V. V. Lezhava. (*Khlop. Delo.*, vi., 3-4, 1927, Moscow. Abstr. in *Rev. Appl. Ent.*, xvi., 3, 1928, p. 131.) *Pyrameis cardui*, L. is recorded from Georgia (Transcaucasia) as attacking cotton. Though the larvæ would not feed under experimental conditions on the leaves or any other part of the plants, they were observed in the field feeding voraciously on the bracts and leaves, the latter being preferred.

456. OTIORRHYNCHUS FAUSTI, STIERL., AS A PEST OF COTTON. (Preliminary paper, in Russian.) By V. V. Lezhava. (*Khlop. Delo.*, vi., 5-6, Moscow, 1927. Abstr. from *Rev. Appl. Ent.*, xvi., 3, 1928, p. 131.) *Otiorrhynchus fausti*, Stierl., has been found feeding on the leaves of cotton in the field in Georgia (Transcaucasia), though the damage so far observed has been negligible.

457. ON THE STUDY OF PARASITE INSECTS, AND THEIR ECONOMIC IMPORTANCE IN THE SUDAN. By H. Bennett Johnston. (A paper read and discussed at a meeting of research workers engaged in Cotton Research in the Sudan, 1927.) The author distinguishes between "parasitic" and "predatory" insects, and deals with the manner in which the parasite insect works, the abundance of species, the variety of their habits, the mobility of the adult, and the economic side of the question. He considers the practical application of the parasitic habit in insects to economic work by (1) the introduction into the area recently infested by a new pest of the parasites which keep it in check in its country of origin; (2) the employment of indigenous parasites to assist in controlling a pest either introduced from abroad, or one which as a native species has passed over from wild to cultivated plants.

It is stated that comparatively little is known of the parasitic Hymenoptera of the Sudan, but mention is made of the following three examples of parasitic insects upon which observations have been made, and which are of great value to the country as beneficial insects: (1) A small Hymenopteron which parasitises the egg-masses of a plant bug infesting dura; (2) A Braconid which parasitizes the Sunt Caterpillar; (3) A Chalcid egg-parasite of the Cotton Stemborer (*Sphenoptera gossypii*, Cotes).

458. EXPERIMENTS WITH THE INFESTATION OF *Locusta Migratoria*, L. WITH BACTERIAL DISEASE. By O. G. Shulguina and P. A. Kalinitshev. (Abstr. from *Rpts. on Appl. Ent.*, vol. iii., No. 1, State Inst. of Experimental Agronomy,

Leningrad, 1927, p. 99.) (In Russian, with Summary in English.) The authors describe experiments with the infestation of *Locusta migratoria* L. with the culture of *Bacillus acridiorum* d'Herelle, and with a mixed culture of bacilli, obtained from the larva of Locusta which succumbed in the laboratory during breeding in low temperature. This culture contained *B. fluorescens liquefaciens*, *B. punctatus* Zimmermann, and *B. acridiocrum* d'Herelle. The best results (90 per cent. of mortality) were obtained by the infestation of the larvæ per os with *Bacillus acridiorum* d'Herelle in the conditions of the alternative temperature (from 12·5° to 23·5° C.). The same culture in the constant high temperature (33° to 35° C.) gave but 10 per cent. mortality. The mixed culture also gave little mortality, *B. acridiorum* in this culture being dislodged by other species of bacilli *B. fluorescens liquefaciens* and *B. punctatus* Zimmermann.

**459.** SODIUM HYDROXIDE. GERMICIDAL EFFICIENCY. By M. Levine *et al* (*Ind. Eng. Chem.*, 1928, **20**, 179-181. Abstr. from *Summ. of Curr. Lit.*, viii., **5**, 1928, A. 4.) The addition of sodium chloride, sodium carbonate, or trisodium phosphate to sodium hydroxide markedly decreases the killing time at 50° and 60° C. The effects of equal weights of sodium chloride and sodium carbonate are approximately the same, whereas the trisodium phosphate is less efficient. As the concentration of salts added to the sodium hydroxide is increased the killing time is decreased, but at a decreasing rate. It is suggested that the undissociated sodium hydroxide may be the agent which penetrates the cell. The addition of the various salts would increase the concentration of the undissociated sodium hydroxide, or possibly decrease the solubility of the sodium hydroxide in the water phase. which would tend to force the sodium hydroxide into the bacterial phase of the suspension. In either case, the effect would be to increase the death rate of the bacteria.

**460.** THE STRUCTURE AND DEVELOPMENT OF THE PERITHECIUM IN MELANOSPORA ZAMIÆ, CORDA. By Isabel Cookson. (*Anns. of Bot.*, xlii., No. clxv., January, 1928.) An attempt to trace the development and morphology of this fungus during its complete life-history. Pure cultures of a species of *Melanospora* that had been isolated by Marsh from a sample of Nyasaland cotton were available. Mr. Marsh had commenced to examine these, but the present investigation was started without reference to the few preliminary observations he had made. The form of *Melanospora* was identified as *M. zamiæ*, Corda, and was considered by Marsh to be unconnected with the diseased condition of the cotton sample. *Cf.* Abstr. 124, vol. iii. of this Review.

**461.** COTTON WILT DISEASE. (*Arkansas Sta. Bull.*, **221**, 1927. Abstr. from *Exp. Sta. Rec.*, 58, **4**, 1928, p. 336.) Considerable attention was given to a study of problems connected with cotton wilt. Selection breeding experiments for wilt resistant strains of cotton were continued, and while some highly resistant ones were secured, they are not sufficiently early for Arkansas field conditions. Abandoning such susceptible varieties as Rowden and Express is recommended.

Further investigations have shown that there is little development of wilt in soil temperatures above 34° C. (93·2° F.), and that the cotton wilt organism is more tolerant to a range of soil temperatures than are various related species of *Fusarium*. As a by-product of this investigation, it was found that soil temperature had a decided effect on the rate of germination of cotton seed, and the emergence and growth of cotton plants during the seedling stage. Soil temperatures as high as 40° were found to promote rapid germination and emergence, although temperatures above 35° usually retarded growth. The extreme rapidity of germination and emergence at high temperatures is said to suggest the possibility of employing soil temperatures as a criterion for planting cotton to avoid slow germination and poor stand resulting from damping-off and seed decay.

In studies of the physiology of the wilt organism, it was found that in the presence of inorganic nitrogen in the form of nitrate, substances are produced which are toxic to the cotton plant, while in the presence of organic nitrogen the solution upon which the parasite has been grown has no harmful effect on cotton.

462. COTTON WILT STUDIES. By V. H. Young. (*Phytopathology*, 16 (1928), 1, p. 76. Abstr. from *Exp. Sta. Rec.*, 58, 6, 1928, p. 548.) Studies of strains of *Fusarium vasinfectum* from several States are said to have shown an appreciable difference in their pathogenicity for cotton, some of them being extremely pathogenic and others less so. Studies were made of the temperature relations of the organism, and the maximum soil temperature for cotton wilt infection was found to be higher than 35° C. (95° F.) and the minimum temperature near 25°.

463. THE CONTROL OF COTTON WILT BY THE USE OF ORGANIC FERTILIZERS. By H. R. Rosen. (*Science*, N.S., lxv., 1695, p. 616, 1927. Abstr. from *Rev. App. Mycology*, vii., 2, 1928, p. 95.) In view of the results of his previous experiments, in which filtrates of pure cultures of different strains of *Fusarium vasinfectum* grown in media containing organic nitrogen proved non-toxic to cotton plants, the author suggests that cotton wilt may be controlled by the use of organic fertilizers. If the disease is severe and cannot be attributed to an abundance of soil-inhabiting nematodes, the soil will probably be found to be poor and deficient in organic matter, while if nematodes are present, the addition of such matter, though it does not preclude the development of wilt, must tend, by stimulating plant growth, to reduce infection.

In the author's opinion, *F. vasinfectum* is a wound parasite (depending for its entry on injuries caused by nematodes and the like), which after entering the root passes a semi-parasitic existence within the water-conducting vessels, largely confining itself to the non-living material. The living tissues must be killed or greatly weakened in advance of the mycelial invasion before the fungus will grow and fructify. This view is in part supported by the fact that inoculum applied to the top of a plant does not induce infection on living parts.

464. ORGANIC FERTILIZERS AND COTTON WILT CONTROL. By H. R. Fulton (*Science*, N.S., lxvi., 1704, p. 193, 1927. Abstr. from *Rev. Appl. Mycol.*, vii., 2. 1928, p. 96.) After a brief reference to the work of Rosen, the author states that his recommendation of the use of stable manure and other organic material as a means of control of cotton wilt, made in 1907 (*Louisiana Agr. Exp. Sta. Bull.*, 96), was based on two seasons' tests at Baton Rouge, on land heavily infected with *Fusarium vasinfectum*, and in which root-knot nematodes (*Heterodoxa radicicola*) were also present. This method should be adopted in conjunction with other measures, such as planting wilt-resistant varieties of cotton, and crop rotation. In further support of his opinion, the author also refers to the investigations of King and Loomis on the beneficial influence of organic fertilizers in the control of cotton root rot caused by *Phymatotrichum omnivorum*.

465. FUSARIUM MOULDS. DESCRIPTION AND CLASSIFICATION. By W. Brown. (*Ann. Botany*, 1928, 42, 285-303. Abstr. from *Summ. of Curr. Lit.*, viii., 6, 1928, A. 7.) A comparative account of about forty strains of Fusarium, the majority of which had arisen as saltants in culture, is given for a number of media. These strains are classified into four groups on the basis of their cultural characteristics on a standard synthetic medium. It is pointed out that this grouping is in agreement with the varying parasitic power of the strains, capacity to parasitize the apple fruit being correlated with the tendency to produce a mycelial type of growth. Some of the saltant strains, though derived from different parents, are indistinguishable. All strains must therefore be considered as varieties of a single species. This species is *F. fructigenum*, Fries. Direct evidence, based on the occurrence of saltations, is also brought forward to prove that a species (*F. salicis*)

allied to *F. fructigenum* cannot be separated from the latter, so that one or other of the specific names should be abandoned. In a discussion of two of the more important papers dealing with the classification of *Fusarium*, it is pointed out that some of the criteria at present adopted are unsound, and that, in view of the apparently widespread occurrence of saltations, a revision of the present system of classification is required. Such a revision would in all probability lead to a considerable reduction in the number of species now recognized.

**466.** MOULD FUNGI. GROWTH IN SOIL. By E. McLennan. (*Ann. Appl. Biol.*, 1928, **15**, 95-109. Abstr. in *Summ. of Curr. Lit.*, viii., **6**, 1928, A. 8.)

**467.** ASPERGILLUS SPECIES. IDENTIFICATION. By G. Smith. (*J. of Text. Inst.*, **19**, 1928. Abstr. from *Summ. of Curr. Lit.*, viii., 8, 1928, A. 10.) An account is given of the general morphology of *Aspergilli*, with special reference to growth on cotton under varying conditions. Plates are reproduced showing the general characteristics of growing cultures. *Aspergilli* do not produce coloured mycelium, but provide visual evidence of their presence by virtue of coloured spores, coloured perithecia, or pigments elaborated in the substratum. The preparation of pure cultures from mould growing freely on the exposed surface of cotton material is described. Wort-agar and prune-juice-agar were used for isolation of species, and Dox's medium for the final cultures. For microscopic study species were mounted in lactophenol, but a modification containing picric acid was found more satisfactory for micrometry and photomicrography. The composition of the mounting fluid is given. The fungi are described and divided into two groups. The first includes all *Aspergillus* species which have been identified as the causal agents in actual cases of mildew damage of yarns and cloths. The second group comprises a number of species which have been found to occur commonly as spore infections of commercial yarns, but which have not so far been found growing on cotton goods. For each species or group the variations in dimensions and colony characteristics are recorded as they have been noted in actual strains isolated from cotton goods. The data given are believed to be sufficient for the recognition of the species listed.

**468.** ON THE INCIDENCE OF LEAF CURL OF COTTON IN SOUTHERN NIGERIA. By C. J. Lewin. (Abstr. from the *Sixth Ann. Bull of the Agr. Dpt. Nigeria*, 1927, p. 70.) *Summary:* (1) Figures of the incidence of the disease of leaf curl on various types of cotton have been given. It is suggested that Ishan cotton (*G. vitifolium*) is slightly more susceptible than Meko (*G. Peruvianum*).

(2) A preliminary investigation has shown that the disease causes a reduction in the size of bolls due to a reduction of the number of seeds per boll. The possibility that fertilization may be inhibited to some extent is suggested.

(3) Evidence that resistance to this disease is hereditary has been adduced, though no crossing experiments have yet been attempted. Two highly resistant strains of Ishan cotton have been isolated.

(4) Even highly resistant cottons appear to become susceptible to the disease during the early rains. No case of absolute immunity has yet been observed.

**469.** NEW MEXICO. COTTON PESTS. (*Thirty-ninth Ann. Rpt. New Mexico Agr. Exp. Sta.*, 1925-26. Abstr. from *Rev. Appl. Mycol.*, vii., Pt. 4, April, 1928, p. 228.) Texas root rot (*Phymatotrichum omnivorum*) appears to be spreading and causing some loss to the cotton crop. Sore shin (*Corticium solani*) was very severe on cotton seedlings in 1926, and a species of *Fusarium* attacked and killed cotton plants in the Rio Grande Valley.

**470.** MACROPHOMINA PHASEOLI (MAUBL.) ASHBY. THE PYCNIDIAL STAGE OF RHIZOCTONIA BATATICOLA (TAUB.) BUTLER. By J. C. Haigh. (*Trop. Agriculturist*, lxx., **2**, 1928, p. 77.)

## *BREEDING, GENERAL BOTANY, ETC.*

471. ACALA COTTON. A SUPERIOR UPLAND VARIETY FROM SOUTHERN MEXICO. By O. F. Cook and C. B. Doyle. (*Circ.* No. 2, 1927, Washington, D.C.) We quote the following from this important paper: "The Acala cotton is a superior upland type discovered by the United States Department of Agriculture in Southern Mexico in 1906, acclimatized in Texas, and established in cultivation, especially in the South-Western States. The Acala variety now forms the bulk of the crop in the irrigated districts of Western Texas, New Mexico, Arizona, and California. Communities have been formed in which no other varieties are grown, and in which stocks of pure seed are maintained.

"The variety is adapted to a wide range of conditions, including all of the principal regions of production in the United States. On account of its ability to produce good crops in short periods, Acala cotton is suited to weevil-infested regions as well as to the short seasons along the northern rim of the Cotton Belt. Acala cotton was grown extensively for several years in Northern Texas, Oklahoma, and Arkansas, with excellent results; but the seed stocks were allowed to deteriorate, and the value of the variety was not generally appreciated.

"Acala cotton is one of the earliest and most prolific varieties of the upland type of cotton, and in many comparisons has given the highest yields, as well as producing better and longer fibre than other large-bolled varieties. The fibre is abundant and of even length on the seeds, and the staple is $1\frac{1}{8}$ to $1\frac{3}{16}$ inches under favourable conditions of growth.

"The upright habit of the Acala plants gives an advantage over the more spreading habit of the Texas big-boll varieties, and makes it easier to keep open lanes between the rows. In the eastern Cotton Belt open spaces between the rows afford better weevil control, since the fallen squares are more likely to be dried out by the hot sun, which kills the weevil larvæ. The stronger stalks and more upright habit of Acala also reduce the danger of lodging of the plants, so that picking is easier and fewer bolls are rotted by lying on the ground.

"Premiums of about 5 cents a pound, ranging from 2 to 10 cents a pound, are obtained for Acala cotton in communities that restrict themselves to the growing of this variety."

The paper, which is furnished with several excellent illustrations, concludes with a list of literature.

472. FACTS ABOUT IMPROVED COTTON SEED FOR NORTH CAROLINA BASED UPON FIELD EXPERIMENTS. (Abstr. from *Agr. Information Circ.*, No. 3, 1927, Dpt. of Agr. N.C. Exp. Sta. State College Station, Raleigh, North Carolina.) From the section headed "Importance of keeping seed pure," we quote the following: "The Cleveland variety of cotton, direct from the breeder, has been compared in twenty-three tests with the same variety which has been in the hands of farmers from three to five years. The average yields per acre have been as follows:

| | |
|---|---|
| Improved Cleveland .. .. .. | 547 lb. lint. |
| Unimproved Cleveland .. .. .. | 474 lb. lint. |
| Difference .. .. .. .. .. | 73 lb. lint. |

"*Note.*—Seed more than two years from the breeder was considered unimproved. The importance of renewing the seed-stock frequently is, therefore, very evident."

473. STRANGE COTTON SPECIES. (Abstr. from *Text. Rec.*, xlv., 539, 1928, p. 44.) The discovery four years ago of an unusual stalk of cotton on the Jim Ford plantation near Sherrill, Arkansas, will result next year in the planting of 150

acres of the new species of cotton that a dozen agricultural farmers have been unable to identify. The stalk was found by Mr. Ford, who was attracted by its unusually large bolls and the strange colour of the squares. He gathered the seed and planted it the next year.

This year he has six bales of the new variety. Last year he sold the new species along with other cotton from his plantation, and was offered from 27 cents to 30 cents per pound. The boll ranges in length from 2¼ to 2½ inches. The squares are deep red and the cotton is of fine texture. It does not require as much attention as other cotton. Mr. Ford said he had sent samples to at least a dozen agriculturists, but not one had been able to identify it.

**474.** STUDIES IN KHANDESH COTTON. Part I. By S. H. Prayag. (*Mems. of Dpt. of Agr. in India*, xv., 1, 1927.) The author states that the object of this study of Khandesh cotton is the discovery and multiplication of a type with a staple length of 24 to 25 mm. (1 inch) and a ginning percentage of 40 or over, with a yield similar to that given by N.R. cotton. The capacity of the local cotton to afford material for this purpose has been almost exhausted, and it is only because of the existence of some lots of seed said to be derived from a cross of Comilla and Bani cotton made in 1908 that any serious advance has been made. By developing pure line cultures from this seed it has been possible to get two types which bid fair to give longer staple cotton, while preserving the high yielding and high ginning characters associated with N.R. cotton. The work is being continued.

**475.** STUDIES IN THE CYTOLOGY OF THE HIBISCEÆ. By W. Youngman. (*Anns. of Bot.*, xli., No. clxiv., 1927.) *Thespesia populnea*, a plant closely allied to *Gossypium*, is dealt with in this paper. The results are summarized as follows:

The process of microspore formation in *Thespesia populnea* is described and figured.

1. Chromosome conjugation in *Thespesia populnea* is of the telosynaptic type.
2. Chiasmatypic figures of the chromosome threads are present in the nucleus during heterotypic prophase.
3. During prophase development the chromosomes pass through a cross-shaped form, from which they emerge as globular bodies.
4. Thirteen globular bodies appear on the equatorial plane of the spindle, which then mass at the centre of the cell and fuse so as to form eight, which regularly arrange themselves in a belt on the equator of the spindle.
5. Different types of anaphase occur.
6. A nodular mass is seen at the poles of the spindle at telophase from which the chromosomes separate out.
7. After a period of interkinesis the chromosomes are seen as cross-shaped bodies. There are typically five crosses in each nucleus, and three extra non-crossed bodies in one of the nuclei. Variations of this arrangement, however, occur.
8. The chromosome bodies appear on the sister equatorial plates of homocotypic division as ten and thirteen bodies respectively.
9. In the pollen tetrad three nuclei contain ten chromosomes, and one thirteen.

**476.** THE INHERITANCE OF RED PLANT COLOUR IN COTTON. By J. O. Ware. (Abstr. from *Arkansas Agr. Exp. Sta. Bull.*, No. 220, 1927.) The presence of pigments known as anthocyanin in the sap of cotton plants is responsible for red plant colour. This colour varies in intensity, but actually exists only in two states—the pure red or homozygous condition, and the unstable dilute red or heterozygous condition. The shades of pure red are wider than the shades of dilute red. The less intense homozygous red can usually be distinguished from the heavier shades of the heterozygous red, where the plants have grown under normal conditions and have had sufficient sunlight.

The weaker shades of the dilute red are easily distinguished from the non-anthocyanic green, unless the latter group possesses an abundance of autumn colouring.

The anthocyanic colour is inherited in the modified monohybrid fashion. The $F_1$ generation from a cross between red and green is dilute red. The $F_2$ generation breaks up into a ratio of 1 red to 2 dilute red to 1 green. When the $F_1$ is back crossed on the red parental strain, the ratio is 1 red to 1 dilute red, and when the $F_1$ is back crossed on the green parental strain the ratio is 1 dilute red to 1 green. All dilute red plants continue to break up into a 1:2:1 ratio, while all pure red and pure green plants breed true.

The mode of hereditary transmission is the same when either the red or the green is used as a female—that is, both direct and reciprocal crosses produce the same ratio.

The red colour furnishes one of the best tools for determining the amount of natural crossing of cotton in the field. The colour follows a definite law of inheritance, is easily detected, and the plants of the following generation can be counted in the seedling stage.

Natural crossing varies with the season and locality. The abundance of pollen-carrying insects influences the amount of crossing. In order to detect natural crossing, the plant that furnishes the pollen must contain a character that appears in the first generation. Much natural crossing occurs without detection because the pollen plant bears no dominant character that shows up in the offspring.

The amount of natural crossing that occurred at Scott was less than 1 per cent., while the average at Fayetteville was 40·9 per cent. This difference must have been due to the season, the number of insect visitations, and the detectable characters carried by the pollen.

477. **Reports from the Turkestan Plant Breeding Station, Tashkent.** In view of the interest aroused by the work that is being carried out at the Turkestan Plant Breeding Station, the Corporation have acceded to requests that they should publish translations of some of the recent papers, the originals of which are in Russian, and are therefore not readily available. It is possible that there are certain imperfections in the translation; for those, and for the opinions expressed, and for any recommendations made, the Corporation undertake no responsibility. The following three papers are included in the present publication.

1. *The Changes in the Properties of Raw Cotton correlated with the Age of the Cotton Plant.* By G. S. Zaitzev and A. M. Gasteva. Investigations carried on by the authors on several bolls of a short-stapled Upland showed that seed cotton undergoes considerable changes dependent on the age of the cotton plant. For each particular character the change goes on in a certain direction. While some of the characters decrease with the age of the cotton plant, as the weights of the seed cotton, seed, and lint per seed, out-turn of lint, and strength and thickness of the lint do, the others, such as the length and twist of the lint, increase. The authors discuss the methods which they used in the investigations, and give also a description of a special apparatus—the xylnometer—which was used for determinations of the lint length.

2. *The Effect of Temperature on the Development of the Cotton Plant.* By G. S. Zaitzev. The author states that temperature is the most important factor determining the rate of the course of growth of the cotton plant. Its influence affects all the stages of development of the plant, such as germination, appearance of the first leaf, appearance of the first buds, flowering and opening of the bolls,

and also all the minor intermediate stages, which determine the alternation of leaves, buds, flowers, and opened bolls. (*Cf.* vol. iv., p. 272.)

3. *A Study of the Root System of the Cotton Plant.* By F. M. Mauer. This paper gives a detailed study of the root system, with interesting figures of rate of growth, development of branches, etc. Contrary to what is stated about the development of roots in other countries, it is said that the main root of the Turkestan variety of American cotton attains a depth of 1 to 1½ metres.

478. SOME PRECAUTIONS OBSERVED IN PICKING SINGLE COTTON PLANTS FOR PURE LINE WORK. By T. Trought. (Abstr. from *Agr. Journ. of India,* xxii., 6, 1927, p. 459.) Describing a calico bag in use in picking cotton from single plants of pure lines.

479. THE OCCURRENCE OF ABNORMALITIES IN COTTON HAIRS. By E. Slattery. (Abstr. from *Text. Rec.,* xlv., 540, 1928, p. 45.) Describes the occurrence of actual knots in cotton hairs. These knots were not found in the raw material from the bale, and it was deduced therefore that they were formed during the mechanical treatment in the mill. From an examination of the cotton after each machine in the spinning process, it appeared that the knotting of the hairs occurred between the points of the cylinder and the flat wires of the revolving card, but the cause of this can only be conjectured. Probably some hairs are caught near the middle of their length and acted upon by localized air currents, then by slight bending of the wire they slip off and form a loop.

## *LEGISLATION.*

480. AUSTRALIA. STATUTORY RULES 1928, No. 15. Regulation 4 of the Cotton Bounty (Seed Cotton) Regulations is repealed, and a new regulation is inserted regarding claims for bounty on seed cotton.

481. TANGANYIKA. GENERAL NOTICE, No 1030. November 8, 1927. Deals with applications for leases of plots at cotton markets, and the conditions under which licences to buy cotton will be issued.

482. UGANDA. COTTON AMENDMENT ORDINANCE No. 14 OF 1927. Amends Section 44 of the Cotton Ordinance, 1926, in regard to cases in which free transport is offered as an inducement to sell cotton. New sections are inserted after Section 50 of the principal Ordinance, which provide for the institution of a cotton-broker's licence and the relevant fees payable.

## *CHEMISTRY AND PHYSICS IN THEIR APPLICATION TO COTTON PROBLEMS.*

483. STUDIES OF QUALITY IN COTTON. By W. L. Balls, Sc.D., F.R.S. (Macmillan and Co. 21s. net.) Dr. Balls begins by considering the subject of graders' judgment, and examples are given to show that while in general, and almost always in the case of cottons with which he is familiar, the grader reveals a most astonishing accuracy, there is also an inherent liability to subjective error. The discussion is illustrated by diagrams depicting the actual facts as compared with the graders' judgments, and, translating it into terms of coinage, he shows that these may err by as much as 2s. in the pound, or even at times more. Whilst these judgments remain of supreme importance in ordinary market work, they are of little more than incidental interest to the breeder of new cottons. What is becoming necessary is a basis of more definite and accurate scientific tests, with an analysis of the graders' "strength," "fineness," etc., into their constituent factors.

Chapter II. describes the microscopic structure of the hair, and is an elaboration, brought up to date, of Dr. Balls' interesting lecture at the British Association of 1923 (E.C.G.R., vol. i., 1924, p. 94.)

Chapter III. deals with the relationship to moisture as an indication of the ultimate structure, and shows that the absorption of water by cotton is not merely mechanical. There are definite kinks in the curve—*e.g.*, at 40 per cent. In Chapter IV. he goes on to quantitative conceptions, and considers the size and variability of the hair. Much of this chapter is a revised reprint of the article in this journal (vol. ii., 1925) upon Weights and Measures of the Cotton Hair. Having considered these general facts, he proceeds in the succeeding chapter to their detailed treatment.

In Chapter V. hair tests are considered, as applied to the raw cotton. Sampling is first dealt with, and the author points out the variability of individual hairs, as well as that of different parts of the bale, together with the unconscious selection that is liable to be practised in sampling. The use of the sorter is described, together with the methods for ascertaining ribbon width, wall thickness, sectional area, hair weight, and other characters.

Part II., "The Yarn," Chapter VI., deals with the study of cotton in yarn, and it is pointed out that yarn is rather to be studied in terms of raw cotton than the cotton in terms of yarn. "The proverb about the strength of a chain residing in its weakest link does not apply to single yarns"; "I have known the length tested in single thread to be increased from 5 cm. to 6,400 cm. without any definite alteration in the breaking load." One thus comes back to the question "What is strength?" and it is pointed out that this is the most important of all, and that in the competition with other fibres it is the strong cottons that will survive. It is then stated that there is a widespread erroneous assumption that drafting improves the sliver by making it more uniform, whereas it is really the effect of the superposition of two or more slivers.

In Chapter VII. cotton machinery is considered, and some of the fundamental defects are pointed out. An especially interesting section deals with breakages in mule spinning due to "nip-ratching," resulting from the sliver being overstrained at the moment of emergence from the roller nips. Chapters VIII. to XI. deal respectively with Drafting, The Product of Sorted Cotton, The Arrangement of Twist, Hair Adhesion and Yarn Rigidity. We then come to Chapter XII., "The Strength of Yarn," which forms the nucleus of the whole discussion. Strength in two yarns, that show equal in the lea test, may be due to very different strength properties, of which the chief constituents are the Strength Gradient and the Peak Strength. This is a long and important chapter, and deals with these phenomena and with testing. It is followed by a chapter on the thirteen samples preserved at Bollington after undergoing every kind of test. The major conclusions reached from the study of these samples are three in number. "First, that the strength of the yarn is in every respect a logical consequence of three chief properties of the cotton hairs. Secondly, that these samples can be arranged in various orders of merit, according to the purpose for which they are to be used. Lastly, that while the lea test is a useful guide to their most likely and usual order, it is always composite, somewhat indefinite, and may sometimes be quite fallacious."

Part III. (Chapters XIV. to XVI.) considers Cotton Growing for Quality, and it is pointed out that improvement in most of the qualities of yarn is in the hands of the grower. Chapter XVII., "In Competition," is specially interesting as pointing out how the price of cotton will gradually rise as available land becomes less and less, and other fibres from poorer land will begin to supplant the inferior kinds of cotton.

An Appendix deals with Methods of Industrial Research, with its conduct by teamwork, its cost, etc., as illustrated in the working of an actual organization.

484. THE RELATION BETWEEN ATMOSPHERIC HUMIDITY AND THE BREAKING STRENGTHS AND EXTENSIBILITIES OF TEXTILE FABRICS BEFORE AND AFTER WEATHERING. By A. J. Turner. (Abstr. from *J. of Text. Inst.*, xix., 4, 1928, T. 102.) The following points, arising out of the results obtained, are discussed in some detail, with a view to assigning explanations for their occurrence:

1. The warp of the cotton fabrics was found to be more affected by humidity changes than the weft; this may be due in some cases to the use of different cottons for the weft, such weft cottons being slightly weaker and less reactive to humidity, possibly because they have been more exposed to sunlight at some stage prior to baling.

2. Mercerized cotton fabrics are far less sensitive to humidity changes than the unmercerized fabrics; this is probably due to mercerization causing a swelling of the fibrils of the cotton fibre, thus making the fibre itself practically insensitive to the effects of humidity.

3. Heavy (coarse) fabrics are more affected by humidity changes than are light (fine) fabrics; this appears to be a consequence of inequality of stress distribution in a breaking test, such inequality being more pronounced for coarse fabrics than for fine.

4. Weathering of the fabrics tends to cause them to be weaker at higher humidities; this appears to be a physical effect following on a chemical change.

5. Different materials are differently affected by humidity; that increases of strength are obtained with any fibre needs an explanation in view of the colloidal nature of the fibres. The results obtained in these experiments appear to throw some light on the structure of the textile fibres; evidence has recently accumulated that these fibres are composed of fibrils running from one end of the fibre to the other. The different reactions of different materials, as well as many other results, can be explained on the additional assumption that these fibrils are not regular in cross-section or in strength throughout their length.

485. THE RÔLE OF MOISTURE IN THE ABSORPTION AND HYDROLYTIC ACTION OF ACIDS IN NON-AQUEOUS SOLVENTS ON COTTON. I. HYDROGEN CHLORIDE IN TOLUENE. By F. C. Wood and E. Butterworth. (*J. Soc. Chem. Ind.*, 1927, 46, Abstr. in *J. of Text. Inst.*, xix., 3, 1928, A. 105.)

486. THE EFFECT OF HUMIDITY ON COTTON. By A. E. Stacey. (*Int. Cott. Bull.*, vi., 22, 1928, p. 309.)

487. ARTIFICIAL HUMIDIFICATION IN THE COTTON-WEAVING INDUSTRY. (Abstr. from *Int. Cot. Bull.*, vi., 22, 1928, p. 345.) A report with the above title has just been published by the Industrial Fatigue Research Board of the Medical Research Board. Dr. A. Bradford Hill, Ph.D., is the author, and the report is published by H.M. Stationery Office at 2s. 6d. The author declares that, after the closest investigation, no significant difference has been disclosed between the sickness rate of weavers in humid and non-humid weaving sheds.

488. VARIOUS KINDS OF TEXTILE FIBRES AND THEIR CHARACTERISTIC FEATURES. By T. Woodhouse and A. Brand. (Abstr. from *Text. Rec.*, xlv., 534, 1927, p. 39.) The authors divide textile fibres into four great groups, indicative of their origin —viz., artificial, mineral, animal, and vegetable—and each group is discussed.

489. GOSSYPOL. PREPARATION AND PROPORTIONS. By E. P. Clark. (*J. Biol. Chem.*, 1927, 75. Abstr. from *Summ. of Curr. Lit.*, viii., 8, 1928, B. 37.) The author has succeeded in preparing pure gossypol, and has studied its properties. Its formula is $C_{30}H_{30}O_8$. The acetate, anhydrogossypol, the dianilide, the dioxime, and the hexa-acetyl derivative have been prepared, and certain analytical data, including optical properties, are noted. *D*-gossypol is not an oxidation or hydrolytic product of gossypol, and to explain the mechanism of the trans-

formation of gossypol to *D*-gossypol, it is suggested that in the manufacture of cottonseed oil, the gossypol present in the seeds is bound by condensing with free amino groups of the seed proteins, forming substances similar in type to dianiline gossypol.

490. COTTONSEED. TOXICITY. By W. D. Gallup. (*Ind. Eng. Chem.*, 1928, **20**, 59-63. Abstr. from *Summ. of Curr. Lit.*, viii., **5**, 1928, B. 20.) An account of an investigation of the relation of gossypol and its related compounds, particularly *d*-gossypol, to the toxicity of certain cottonseed products. From the results, it is concluded that the toxicity of cottonseed meal may be due not only to the presence of ether-soluble gossypol, as it is found in cotton seeds, but also to the presence of what appears to be a decomposition product formed during the heating of the seeds previous to expressing the oil, and given the same *d*-gossypol. In spite of its higher content of *d*-gossypol, the meal investigated was much less toxic than the heated seeds. Cottonseed may be rendered non-toxic by autoclaving in a wet condition. By heating for a short time in the dry condition, the gossypol in the seeds is partially converted to the insoluble form. The insoluble gossypol so produced is much more toxic than the insoluble form found in cottonseed meal or in seeds which have been subjected to steam heat. The determination of *d*-gossypol by the present chemical methods is not a safe criterion for estimating the toxicity of cottonseed products.

491. IMMUNIZED AND AMIDATED COTTON. By S. R. Trotman. (Abstr. in *Summ. of Curr. Lit.*, viii., **9**, 1928, K. 47.)

492. IMMUNIZED COTTON. PREPARATION. By J. T. Marsh. (*Ind. Chem.*, 1928, **4**, 57-59. Abstr. from *Summ. of Curr. Lit.*, viii., **5**, 1928, K. 30.) A general article dealing with the preparation, properties, and utilization of immunized cotton.

493. SOME RELATIONS OF THE PHOSPHOLIPINS IN SEEDS TO OTHER CONSTITUENTS. By N. B. Guerrant. (*Jour. Agr. Res.*, vol. xxxv., No. 11, 1927, p. 1001.)

494. CHEMISTRY AND ITS RELATION TO COTTON MANUFACTURING. By H. D. Martin. (*Text. Rec.*, xlv., **539**, 1928, p. 43.)

495. COTTON OPENER. DESCRIPTION. By J. Forkin. (E.P. 283655 of October 16, 1926. Abstr. in *Summ. of Curr. Lit.*, viii., **6**, 1928, F. 11.)

496. COTTON OPENING AND CLEANING MACHINERY. EFFICIENCY. By J. W. Cooper. (*Text. World*, 1928, **73**, 698 and 745. Abstr. from *Summ. of Curr. Lit.*, viii., **6**, 1928, F. 11.) An account of experiments conducted under mill operating conditions to ascertain as nearly as possible the comparative efficiency of each machine used in a certain plant for cleaning raw cotton. Analyses of the waste from each unit are given and used as the bases of efficiency determinations. Figures for various units show that the efficiency varies with the amount of previous cleaning the cotton has received, and with the location of the unit in the system. The opening and cleaning machinery which precedes the lappers removes two-thirds of all the dirt, leaf, and trash, and is thus of extreme importance. In the plant tested, the vertical opener was found to be a much more efficient machine than either the three-blade beater which preceded it or the horizontal cleaning machine that followed, and its efficiency was practically constant, even after considerable waste had been out. The horizontal cleaning unit appeared to be better suited for cleaning comparatively dirty rather than comparatively clean cotton. Of the two samples of cotton used in the tests, the drier did not appear easier to clean.

497. FIBRE CLEANING APPARATUS; DESCRIPTION. By E. H., D., and F. Ellis (Manchester), E.P. 280704 of November 11, 1926. (Abstr. from *Summ. of Curr. Lit.*, viii., 2, 1928, F. 5.) A machine for extracting dust, burrs, and other foreign substances from fibres, etc., comprises a stationary cylinder the lower half of which is perforated, and a rotating shaft carrying longitudinally disposed bars or rods which move round close to the lower half of the cylinder. The rods may be inclined to feed forward the material from the inlet to the lower end of the cylinder, which may be inclined or of conical form. A wire, or rope, with suitable tensioning means may replace the rods. The machine may be used to mix fibres, in which case only a portion of the lower half of the cylinder is perforated.

498. NEW DRAWING-IN MACHINE. (Abstr. from *Int. Cot. Bull.*, vi., 22, 1928, p. 313.) Describes a warp drawing-in machine recently developed by the firm of Zellweger S.A., Uster, Switzerland.

499. DRIVING OF COTTON-SPINNING MULES. (*Text Rec.*, xlv., 539, 1928, p. 42.)

500. PNEUMATIC LOOM. (Abstr. from *Int. Cot. Bull.*, vi., 22, 1928, p. 313.) An Armentières workman, Henri Maes, has constructed a loom in which the shuttle is moved to and fro by compressed air, and all cog wheels, picking rods, and eccentric movements are done away with, consequently reducing considerably the noise of the working of the loom. The healds are likewise moved by compressed air. Much higher speed than is at present obtained is claimed for this loom. Whether the rubber blocks which fasten up the air holes will stand the industrial wear and tear is a problem which can only be solved by actual experience in the mill.

501. COTTON FABRIC: MERCERIZING, DYEING. British Dyestuffs Corporation, Ltd., and A. J. Hailwood, Blackley, Manchester. (Abstr. in *J. of Text. Inst.*, xix., 3, 1928, A. 103.)

## *MISCELLANEOUS.*

502. COLONIAL AGRICULTURAL SERVICE. Report of a Committee appointed by the Secretary of State for the Colonies. (Cmd. 3049. Pubd. by H.M. Stationery Office, 1928. Price 9d. net.) The Committee was appointed to formulate practical proposals, for submission to the Colonial Governments, to give effect to the Resolution of the Colonial-Office Conference on the subject of Colonial Agricultural Scientific and Research Services. These proposals should include a scheme, based on contributions to a common pool, for the creation of a Colonial Agricultural Scientific and Research Service available for the requirements of the whole Colonial Empire, for the support of institutions needed for that purpose, and for the increase of research and study facilities in connection with the specialist agricultural services of the Colonies generally.

One of the first recommendations made (*cf.* this journal, p. 161 of 1928) is that "agricultural" and "research" officers be kept in one category.

In Part II. the Headquarters Council is considered and its composition outlined. Its functions are to advise on the following matters:

(*a*) The supply and training of specialist and agricultural officers for the Colonial Agricultural Services, in conjunction with the recruiting authorities of the Colonial Office.

(*b*) The establishment of Central Research Stations and general guidance of their work.

(*c*) The efficiency and general well-being of the unified Colonial Agricultural Service, including such advice upon the Agricultural Services as the Secretary of State or Colonial Governments may desire.

(*d*) The collection, collation, and distribution of scientific and agricultural information in fields not covered by other agencies.

(*e*) Main research policy in the Colonial Empire.

(*f*) The representation and collaboration of the Colonial Empire as a unit in Imperial schemes of research and in Imperial Bureaux and Correspondence Centres.

(*g*) The general progress of agriculture and food production in the Colonial Empire.

The idea of forming a pool from which officers may be drawn as required is regarded with some misgiving (p. 16).

In Part III. the chain of Central Research Stations is considered, the staff necessary is outlined, and the salaries recommended.

Part IV. deals with the Colonial Agricultural Service, and as already mentioned, great stress is laid on the inclusion of "agricultural" and "specialist" (*i.e.*, Research) Officers in the one class. Provident funds, promotion, transfer, and other matters are also dealt with.

In Part V. the question of finance is considered. (*Cf.* vol. iv., Abstr. 320, p. 245, and vol. v., p. 161, of this Review.)

**503. Survey of Textile Industries.** This publication (which deals with the Cotton, Woollen, and Worsted and Artificial Silk industries) forms one of the four parts into which the Survey of Industries prepared by the Committee of Industry and Trade is divided. The first and second parts of the series discuss certain factors in industrial and commercial efficiency which are common to industry in general; the third part, "Survey of Metal Industries" (published by His Majesty's Stationery Office at 5s.) and the present volume form part of a single study, the object of assembling the surveys being to give a picture of British Trade and Industry as a whole, and to facilitate the study of each industry's problems in the light of those faced, and perhaps surmounted, by others.

The "Survey of Textile Industries," which contains 328 pages, and includes a comprehensive index, is published at the price of 3s. 6d. by His Majesty's Stationery Office, and can be obtained either directly, or from the depôts of that department, or from any bookseller. The contents of the volume are based partly on official data, partly (and generally speaking preponderantly) on information supplied by the trades themselves, and partly on the results of other official and unofficial enquiries; they are as follows:

I. *Introductory and Historical.*—Origins; Concentration in Lancashire; Rapid Growth of the Industry; Development of the Industry Abroad; Competitive Advantages of Lancashire; International Trade in Cotton Yarns and Manufacture.

II. *Organization.*—Number and Size of Separate Sections; The Liverpool Cotton Market; The Market for Manufactured Goods and the Functions of the Shipping Merchant; The Yarn Market; Spinning and Weaving; Localization; Types and Sizes of Businesses in Spinning and Weaving; Opportunities for Advancement; Finishing Trades; Trade Associations and Trade Unions, etc.; Research.

III. *Economic Condition of the Industry.*—Productive Capacity; Output of Yarns and Piece Goods; Changes in the Number of Persons in the Industry; Variations in Prices and Margins; Depression in the American Spinning Section; Over-Capitalization of Spinning Mills; Position in the Fine Spinning Section; The Sewing Thread Combination; The Weaving Section; The Finishing Trades; Discussion of Finishing Charges.

IV. *British Trade in Cotton Yarns and Manufactures.*—Dependence of the Industry on Export Trade; Analysis of Exports by Destinations; Qualitative Changes in the Export Trade.

V. *The British Cotton Industry and Trade in Relation to that of the World.*—Development of the Cotton Industry in other Countries; Comparative Position of British Overseas Trade Yarns; Piece Goods.

The following Appendices are also included:

(1) The Raw Cotton Supply; (2) Notes on the Cotton Industry and Trade in other Countries; (3) Changes of Capitalization in the Cotton Spinning Industry; (4) Charges and Costs in the Finishing and Laying-Down of Cotton Piece Goods; (5) Relative Movements of Raw Cotton, Yarn, and Clother Pieces; (6) Miscellaneous Statistics.

This publication should prove of great interest to those who take a thoughtful interest in British Trade and Industry as a whole, and should find a place in every library concerned with cotton.

**504.** EFFICIENCY IN THE COTTON INDUSTRY. By Prof. W. E. Morton. (Abstr. from *J. of Text. Inst.*, xix., 2, 1928, p. 17.) In reviewing the position, the author states that the demand for Lancashire goods has shrunk to about 70 per cent. of the pre-war volume, this being due principally to the competition of such countries as Italy and Japan. The difficulties caused by the financial methods practised in 1919 are also pointed out.

Professor Morton states that cheap production is not possible with short time, that contraction is needed to enable expansion later, and that the solution of the problem probably lies in the closer coordination of the producing units and more intense specialization. He is of opinion that the cotton industry is run too much like a series of watertight compartments, and that Lancashire does not seem to realize that her great problem is not at all one of internal competition, but competition as between her industry as a whole and the rest of the world. He suggests a sharing of capital between groups of mills spinning the same kind of cotton into similar counts, and specializing each mill for one count of twist and one of weft in proportion to the ascertained demand. With this would go cooperative buying of raw cotton, and cooperative selling. The combine would be managed by a council, and would employ research technologists.

**505.** FIFTEEN YEARS' RETROSPECT OF THE EXPANSION OF THE WORLD'S COTTON SPINNING INDUSTRY. An Address delivered by Mr. F. Holroyd, President of the International and of the English Federation of Master Cotton Spinners' and Manufacturers' Associations, at the Members' Dinner of the Manchester Cotton Association, held in April, 1928. (Abstr. from *Int. Cot. Bull.*, vi., 23, 1928, p. 538.) Mr. Holroyd states that during the last fifteen years, which takes us back to just before the war, there has been an increase of 21,530,000 spindles in the various countries of the world! Asia heading the list with 9½ million spindles. England, however, has still the preponderating number—viz., 57½ million, about 80 per cent. of which were in pre-war times always working for the export trade and principally for the Far Eastern markets; Lancashire, therefore, particularly feels the Asiatic addition of spindles because of the danger of their replacing Lancashire yarns. The difficulties of those countries which in pre-war times were large exporters of cotton goods have been further increased by the fact that local taxation has in many cases advanced three times as much, and national taxation perhaps twice as much as before the war.

The question of working hours in the various countries is discussed. In regard to the two-shift system, the author states that it has the great disadvantage that as soon as trade becomes good, several countries start on more than one shift, and the demand is immediately satisfied, so that the industry moves from high tide at once to low. The great advantage of the two-shift system is that it reduces overhead charges (which are generally more than 40 to 50 per cent. in the cost) by about 40 per cent., and enables the replacement of machinery in ten years instead of twenty, thus making it possible for the mill owner to introduce more frequently new machinery with a higher output.

**506.** Research Work in Agriculture. (*United Empire*, xix., 1, January, 1928, pp. 32-35.) An address delivered by Sir John Russell at the Royal Colonial Institute. The work of Rothamsted is summed up in the final paragraph; it is "to discover the cause of things that happen in the soil and in the plant, causes that determine the results on which the success or failure of the grower depends. Once the causes are known, some kind of remedy can usually be designed, but until they are known nothing can be done with certainty. The discovery of the causes requires scientific research of a kind which does not always seem to bear directly on practice. But the true test of research is the soundness of the knowledge which it yields, not the immediate practicability of the results. If the knowledge be accurate it will find its use. If it be inaccurate it will be useless, and may even be seriously misleading. Research lies at the basis of successful productive enterprise."

**507.** Research in the Cotton Industry. (Edited by R. H. Pickard, D.Sc., F.R.S., Director of Research, Shirley Institute.) A review of the work of the British Cotton Industry Research Association up to the end of 1926, carried out under the direction of the late Dr. A. W. Crossley. The report, which is well illustrated, deals with the following: Some special applications of research methods; Characterization of cottons by means of physical and chemical tests; Researches on spinning and doubling, sizing, weaving, scouring and bleaching, mercerization, dyeing, printing and finishing; New mechanical testing instruments and appliances; Raw cotton, and some fundamental properties.

**508.** The Path to a Successful Future. By Lieut.-Col. N. Seddon Brown. (Abstr. from *The Future of Cotton and the Progress of Horrockses*, published by *The Commercial*, Manchester, April 19, 1928, p. 5.) In this article Col. Seddon Brown points out that while strenuous efforts to reduce costs will do much to recover some of the trade in coarser fabrics that Lancashire has lost, hope for the future lies rather in the better utilization of the many advantages which Lancashire possesses in the production of the finer and more diaphanous fabrics which certain fashions demand. He states that the scientific mixing of artificial silk with cotton is a matter which offers great scope for further development, and the mills of Horrockses, Crewdson and Co., in Preston, have spent much time and money in producing cloths of this character.

**509.** The Future of the Cotton Industry. By A. B. Cox. (Abstr. from *Int. Cott. Bull.*, vi., 23, 1928, p. 453.) Discussing the question, and indicating that the future lies in the direction of greater co-operation.

**510.** The Liverpool Cotton Association. The Cheapest Market. By A. C. Nickson. (*The Commercial*, Ann. Rev., 1927. Published January 26, 1928, p. 7.) A description of the Liverpool Cotton Market and its business.

**511.** Cotton Mill Valuations. By G. F. Singleton. (*Text. Rec.*, xlv., 538, 1928, p. 36.)

**512.** Cotton for Roadways. (Abstr. from *Text. Rec.*, xlv., 541, 1928, p. 78.) A new cotton fabric for use in roadway construction has been produced by the American Cotton Textile Institute. The fabric, a loose cotton mesh, is laid over a cement base, and on top of this is moulded the surface of the roadway. The layer of cotton mesh serves as a cleavage between the surface of the road and the foundation. By this method road repair will be effected much more easily, since the top surface will be easier to remove without disturbing the foundations.

**513.** The Principles of the Division of Labour and their Present-Day Significance to Medium-quality Spinners. By E. E. Canney. (*Text Rec.*, 1928, vol. xlv., Nos. 538, p. 42 and 539, p. 42.)

514. COTTON OPERATIVES. HEALTH HAZARDS. (*Bull. Hygiene,* 1928, 3, 220. Abstr. in *Summ. of Curr. Lit.*, viii., 9, 1928, M. 12.)

515. We have received from Messrs. J. and H. McLaren, Ltd., Leeds, copies of their new catalogues, Nos. 58 and 60, illustrating and describing the McLaren-Benz Diesel Oil Engines, and their application to Agriculture, etc. The engines are mostly of the high speed type.

## *ADDENDUM.*

516. LANCASHIRE UNDER THE HAMMER. By B. Bowker. (Pubd. by the Hogarth Press, 52, Tavistock Square, London, W.C. 1, price 3s. 6d.) We have recently received a copy of this book. The author commences with a description, in picturesque language, of the outstanding pre-eminence of Lancashire in the spinning trade during the first part of the century, and the way in which she reaped the reward of her improved efficiency, until in 1919-20, to quote Tattersall, "Sellers had buyers in the hollow of their hand," and profits were enormous. Examples are quoted where the profit had increased from ½d. before the war (and even that was regarded as good) to 1s. 6d. after. Lancashire is described as having "lost its head, and taken to gambling in mills, weaving sheds, shares, etc." This went on to such an extent that about half the industry underwent financial reconstruction.

The war, with its interference with cotton supply, forced many other countries to make all they could at home, and now the position is that they make much cloth, and make it more cheaply, than it can be bought from Lancashire, whose exports have gone down roughly from 7 to 4. In the chapter headed "Seven Terrible Years," the author discusses the disastrous effects upon the masters and the workers of this great fall. Spinners' margins, which on April 1, 1920, were 43·32d., had shrunk by December 3, 1927, to 5·72d. Such a collapse has placed several mills to a large extent in the power of the banks, who have given overdrafts. With the continuance of bad times, the loan indebtedness of the spinning companies has gone on increasing. The author develops the thesis that the way out of the morass is for the cotton men to make common cause among themselves, but admits that this is a proceeding that is unusually difficult in a country of such pronounced individualism. Reduction of cost of production was hailed as the remedy, and it is described how the first step taken was an attempt to reduce wages; it is argued, however, that a fall in wages of one-eighth would only reduce prices of unfinished cloth by less than 2 per cent.

In the section bearing the title "On the Threshold—of What ?" the author deals with the loss of markets, and the ignorance that still exists as to the actual causes of this loss. He then considers "the way out," and suggests that it lies in co-operative effort, with a general "Control Board," which should have powers of compulsion, by which it could put a stop to underselling, encourage the formation of larger units (thus reducing costs), and overcome the great financial depression by compromise with the banks and in other ways.

The book is one which no one concerned with cotton can afford to leave unread, however much he may disagree with some of the author's views.

# PERSONAL NOTES

It is with much regret that we have to announce the death, on May 5, at Rochdale, of Mr. J. M. Thomas. Mr. Thomas was a member of the Executive Committee of the Corporation, and of the East Africa Sub-Committee.

## OFFICERS ON LEAVE.

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes "home" on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton. The Corporation would consequently much appreciate the courtesy if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would call at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street) immediately opposite to the offices of the Crown Agents for the Colonies.

At the date of writing the following officers are on leave in England from cotton-growing countries:

| | |
|---|---|
| Ceylon | Mr. T. H. Parsons. |
| Gold Coast | Mr. A. B. Culham. |
| „ „ | Mr. G. H. Eady. |
| Iraq | Mr. F. K. Jackson. |
| Kenya Colony | Mr. A. S. Hartley. |
| Nigeria | Mr. O. T. Faulkner. |
| „ | Mr. G. W. C. Briggs. |
| „ | Mr. W. E. de B. Diamond. |
| „ | Mr. F. D. Golding. |
| „ | Mr. J. O'N. Hewitt. |
| „ | Mr. C. J. Lewin. |
| „ | Mr. J. K. Mayo. |
| „ | Mr. J. W. R. Peddar. |
| „ | Mr. H. G. Poynter. |
| Nyasaland | Captain C. Smee. |
| Sierra Leone | Mr. D. W. Scotland. |
| Tanganyika Territory | Mr. R. W. R. Miller. |
| „ „ | Mr. A. Pitcairn. |
| „ „ | Mr. F. M. Rogers. |
| „ „ | Mr. C. M. H. Sutherland. |
| Uganda | Mr. H. Hargreaves. |
| „ | Mr. L. Hewitt. |
| Zanzibar | Mr. V. H. Kirkham. |

The following officers of the Corporation's staff abroad are on leave in this country.

| | |
|---|---|
| South Africa | Mr. S. Milligan. |
| „ „ | Mr. T. C. Cairns. |
| Trinidad | Dr. T. G. Mason. |
| „ | Mr. J. B. Hutchinson. |

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# THE EMPIRE COTTON GROWING REVIEW

VOL. V. OCTOBER, 1928. NO. 4

## HISTORY REPEATS ITSELF

THE following article, copied from the *Illustrated London News* of April 20, 1861, is of some interest at the present time:

### INDIAN COTTON

Recent as well as present events in the North American States make it imperative on us to reconsider the question of our cotton supply. We have accustomed ourselves to believe that the days of monopoly are past in our part of the world; but we may find to our cost that monopolies may be securely maintained on other foundations than mere legislative enactments. The present condition of our cotton supply furnishes a case in point. Although free to obtain this commodity from any region of the earth, we have permitted the Southern States of North America to acquire almost a monopoly of the supply. And what is the result? Why, that there has been well-nigh a crisis in the cotton market. It is the old story of allowing the pyramid to rest on its apex, with the certain result of its overturning with a crash whenever the support becomes in the slightest degree unsteady. Hence the revolution in progress in the Cotton States of America may suggest the danger of a similar catastrophe overtaking sooner or later the trade of our cotton-manufacturing districts in Lancashire. It is very plain that we must have cotton, and that to an immense amount. Many millions of our population are directly dependent upon the cotton manufacture, and any great disaster in that particular branch of industry would sensibly affect nearly the whole population. No reverses in war could inflict on the country such terrible immediate results as would a stoppage of our cotton manufacture. And yet our "cotton lords" are content to put it in the power of a single country to bring about, if it please, this very result. As if the trade, under any circumstances, was not sufficiently precarious, they must needs embark the whole of their property, so to speak, in a single venture.

Why should our cotton supply not be mainly obtained from within the limits of our own empire? No doubt there are difficulties in the way. For instance, some may object that the requisite quality of staple cannot be obtained from India or any other part of our own dominions; and, further, that the distance and means of conveyance are also most serious obstacles. But would not the security of the supply, when once established, be an important set-off against some of these disadvantages? It is better to live on black bread than starve; and would it not be possible to improve the quality as well as keep up the quantity of the produce? There are few things that British capital, directed by British skill and energy, cannot effect. Can it be that India, the native country of the cotton plant, and celebrated long before the days of Herodotus for its growth and manufacture of cotton, cannot be made to produce cotton equal to the finest that is grown? Some high authorities maintain that even the present growth of Indian cotton is at least equal, if not superior, to the best North American in certain respects. One of the most serious obstacles, however, to an increased cultivation of cotton in India is the difficulty of transit from the seat of production to the ports of this country. If the query were put to an unsophisticated outsider, uninitiated in the facts of the case as to wherein lies the chief source of trouble and expense in bringing cotton from India, he would most probably say, " In the long sea voyage." " Not at all," would be the reply. Know that the main difficulty and expense are generally incurred before ever the cotton leaves the shores of India. The " Slough of Despond " to Indian cotton prospects are the Indian roads. An Indian road is a curious thing. Suppose the dry bed of a considerable mountain torrent placed a little nearer the horizontal than it usually lies, and, perhaps, it may supply some tolerable notion of the state of an Indian road. A writer on India, speaking of the province of Candeish, says:—" In the year 1847 the collector of the district was compelled to grant the cultivators remissions of the land tax, not from any successive failure of crops, but the very reverse. The yield of the province had become augmented so far beyond the local requirements, and the state (or rather total want) of the roads was such a barrier to the disposal of their produce elsewhere, that their crops lay useless on their hands, and they found themselves without the means of meeting the assessment."

The *Calcutta Review* of December, 1851, speaks (although we should like to be more sure than we are whether it means it in jest or in earnest) of a portion of one of the ordinary Madras roads being actually used for the somewhat novel purpose of testing the strength of the materials of new gun-carriages, which, it seems, are pronounced

Methods of Conveying Cotton in India to the Ports of Shipment

safe if they pass this severe ordeal. Now, if the majority of the roads of India are in a condition that would render them equally suitable with this Madras highway for straining new or old materials to their utmost, we can see one very evident reason why the cultivation of cotton throughout India can never advance very greatly beyond its present extent. A gentleman who was an eye-witness to the facts he relates thus refers to the perils of cotton bales on their pilgrimage from the plantation to the nearest Indian port. This port may probably be distant 1,000 miles; and if the owner of the cotton live sufficiently near to some river station on the Ganges, after getting through the difficulties of the transit on such Indian roads as we have described, he may at length find his cotton produce on the banks of the river. Are his difficulties then at an end by his finding at this point a safe and ready conveyance for his property to Calcutta? Not at all. If he aims at embarking it on a river steamer he may find that the few that exist are all booked for many months to come; or, if such should not be the case, the cost demanded for carriage is so heavy as would at once destroy all hope of profit from his goods. In this state of things his *dernier ressort* is a country boat, which is a rickety conveyance under the most favourable circumstances, but becomes alarming to contemplate with his cotton bales piled upon it. There is no help or choice left, however, so the boat is dispatched; but when it will arrive at its destination, or in what state its cargo will be delivered, are events that lie shrouded in the most absolute uncertainty. If it happen to be the hot season the crazy craft will most likely lie on some sandbank for weeks together; if, on the other hand, through delay it should be overtaken by the rains, it is 1,000 to 1 but that the top-heavy vessel will be capsized in a squall, and the luckless freight, if not totally lost, will almost to a certainty be irremediably ruined. Nor is the sum of its mischances yet at an end, for the probability is that even on the most favourable voyage the inflammable cargo will be set on fire on an average every alternate day, from the boatmen cooking their meals, each man using his separate charcoal-pan.

Our illustration, sketched by an eye-witness of the scenes he depicts, represents some of the obstacles that impede the carriage of cotton on Indian roads.

With the substitution of tropical Africa for India, the above might almost have been written during the last couple of years. India is now well supplied with transport facilities, and Africa must be provided with the like before it can become a great cotton-producing country.

# NOTE ON THE WORK OF THE PHYSIOLOGY DEPARTMENT OF THE CORPORATION'S COTTON RESEARCH STATION, TRINIDAD

BY

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WORK has now been in progress at the Physiological Department of the Cotton Research Station for some eighteen months. Plant Physiology is one of the youngest of the sciences, and is concerned with the mechanism of growth and development. The instruments it employs are chemistry and physics. As examples of the type of problem that confronts the cotton physiologist, the following may be mentioned.

Jassid attack is one of the most serious factors reducing the yield of cotton in South and East Africa. The damage done depends very largely on the variety grown. It also depends, however, on the plant's environment, both of soil and climate. Jassid damage is, for instance, unknown in West Africa, though Jassids are often present in abundance. The plant breeder approaches the problem by endeavouring to breed out resistant varieties. The physiologist, on the other hand, is more concerned with the part played by soil and climate in influencing the susceptibility of the plant. He wants to know the chemical and physical basis of susceptibility, and how it may be controlled. There are a number of insect pests of this type. Thus in Nigeria *Helopeltis* gives a great deal of trouble in some localities, whereas in others it is rarely seen. It is noteworthy that American cotton is more resistant than the native varieties.

The part played by the environment in predisposing the plant to fungous and bacterial diseases will also be an important field of work for the physiologist. Thus the growth of the organism responsible for Blackarm, a source of considerable loss of crop in the Sudan, is apparently affected by such factors as the nitrogen supply to the leaf, and particularly by soil temperatures. There is, in addition, a mysterious group of diseases apparently not due either to fungi or bacteria. They are generally referred to as physiological diseases.

The leaf roll of American cotton that occurs in Nigeria is an example. A wet soil and bright sunshine are in some way predetermining factors. The disease is probably similar to the Curly Leaf disease of the West Indies.

Next we consider a rather different group of phenomena. There is, first of all, the problem presented by the shedding of flower-buds and bolls. The causes are very far from clear, and whether anything can be done to remedy it is still uncertain. Secondly, there are those agriculturally important modifications of habit that are due to climate. Sakel cotton, for instance, in the Sudan produces its fruiting branches much higher up the stem than in Egypt, thus causing a considerable delay in the setting of the crop. A shedding of the terminal buds leading to a great development of vegetative branches is reported from Queensland. The causes of these and similar alterations in habit are quite unknown. Moreover, the character of the lint is just as profoundly modified by changes in climate. Thus the shortish stapled Webber 49 of America, when grown in Mesopotamia, produces a lint not far behind Egyptian Sakel in spinning qualities, while the superfine cotton of St. Vincent produces a coarse, relatively short-stapled cotton when grown in the Sudan.

The above are typical examples of the kind of problem that awaits the attention of the plant physiologist. Now at first sight it might appear that the best course would be to choose some economic problem such as boll shedding, or the production of thin-walled hairs (which give rise to nep), and to drive ahead at it. Unfortunately plant physiology is still too young a science to make this procedure profitable. We are brought up at every turn by our ignorance of the fundamental physical and chemical processes that underlie the normal development of the cotton plant. It seemed to us in Trinidad that in the long run progress would be most rapid if we paused and set to work as a preliminary to clear up some of the basal physiological problems. It is for this reason that we have devoted most of the past eighteen months to making a study of the machinery responsible for the supply and distribution of foodstuffs to the component parts of the cotton plant—that is to say, to stem, root, boll, etc. As the full report of our work is at present appearing in the *Annals of Botany*, and is, moreover, somewhat technical, a brief description will here suffice. While the means whereby water is lifted from the roots to the top of a tree is so striking a phenomenon that even the most casual observer is struck by it, the migration of nutritive substances from the leaf, where they are manufactured, to the roots, fruits, etc., generally passes unnoticed. Yet enormous quantities of material are moved, and are moreover moved at very high speeds. The factors responsible for this migration of elaborated foodstuffs have always been obscure. We will take the case of the boll on a cotton plant and see how it is able to obtain its supply of sugar, for sugar is the raw material employed in the manufacture of cellulose, the substance of which the hair is composed. Movement occurs through long tubular cells that stretch all the way from the leaf to the roots, the stem and the boll. The level of sugar concentration is higher in these conducting tubes in the leaf than it is in either the boll or the root. Movement of sugar takes place from the region of higher concentration to the region of low concentration, just as it does in a diffusion tube in the laboratory. The rate of diffusion is, however, fifty thousand times faster in the plant than it is outside it. How this acceleration is brought about is a complete mystery. Boll and root thus obtain their supply of sugar because the concentration of sugar is less in them than it is in the leaf. Usually the boll is able to exert a greater pull than the root on the sugar, and, it may be added, on the nitrogen compounds of the leaf. Root development generally ceases, therefore, as a result, once bolling gets under way. Now if for any reason the concentration of sugar in the leaf drops, as it does on wet days, or if the concentration in the root were to sink below that in the boll, then the supply to the boll would be cut short. Should this occur when the boll is young, it is apparently shed; and should it occur when the boll is more mature, thin-walled fibre should result. The factors responsible for the differences in concentration in the various parts of the plant are thus of very real importance in determining both the habit of the plant and the quality of the lint.

The distribution of nitrogen compounds takes place in substantially the same way as that of sugar. We have in the course of our work been struck by the overwhelming importance of nitrogen in the economy of the cotton plant. The distribution of nitrogen appears to be a most important factor in limiting the growth of the cotton plant. As nitrogen is so generally deficient in tropical soils, we propose making a study of the methods at present in vogue in conserving the nitrogen supply of the soil.

Recently another line of work has been initiated. The part played by the cotton stainer in carrying the fungi responsible for the internal boll disease is now well known. The ravages caused by these internal boll rots in tropical Africa are also recognized. In the West Indies it has been possible to control the cotton stainer by the removal of the wild food plants. In tropical Africa this procedure is for a number of reasons impossible. It occurred to us that something useful might, however, be achieved by studying the factors responsible for variations in susceptibility to the fungi which give rise to the internal boll diseases. It is too early yet to say what will emerge from this method of tackling the problem, but we think it will be agreed that it is time the stainer problem was approached from the physiological standpoint.

To sum up: The problems which we want to solve and which are of such importance to the spinner are those on which depend the quantity and quality of cotton, as, for example, boll shedding and boll disease.

In all cotton-growing countries attempts are being made to overcome these troubles, but it is only at a research station such as that which the Corporation have established in Trinidad for the express purpose of studying the fundamental causes that lie behind these things that systematic investigations of this kind can be carried out.

Our plan of campaign is based on the belief that before we can find out why the cotton plant so often does not grow as well as it might, or does not produce as much lint as perhaps it should, we must ascertain first how and why it grows at all, what is the mechanism concerned in conveying nutrient matter from one part to the other, and so on. When we have learned that, we hope to be able to find out what is happening when the normal functions are not working properly—for example, *why* exactly bolls are shed.

Whether we shall then be able to go a step further and, having diagnosed the cause of that and similar phenomena, be able to devise a cure is a question we are naturally quite unable to answer, but we are convinced that our best hope of doing so lies in first patiently finding out all we can of the plant's normal physiology and life.

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# SCIENTIFIC RESEARCH AND AGRICULTURAL DEPARTMENTS

BY

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This may well be called the age of Science. Never in the history of man has the scientist come into his kingdom so fully as during the last few years, and this is as true of the agricultural scientist as of those working in other directions.

In almost every branch of industry the results of scientific research are being applied, or research is being carried on in an attempt to obtain knowledge that can be applied, to render production or manufacture more economic.

In the case of almost every commercial commodity new or improved processes, the fruits of scientific investigations, are being applied in production, manufacture, handling and utilization. In some instances research has resulted in the production on a commercial scale of commodities previously unknown, and the consequent creation of entirely new industries. It is probably not too much to say that in many branches of British industry today, success depends very largely, if not in fact entirely, upon the scientific research that has been carried on in the past, and is being pursued with increasing intensity at the present time.

The success of this alliance with science has been so definite in the case of some of our industries that it is not surprising to find that more research, and more scientific application of existing knowledge, are regarded by many as the only means of improving those branches of industry which are still in a depressed condition.

Taken generally, agriculture must be regarded at the moment as being in this category. It is true that in various parts of the world some forms of farming are being carried on on a profitable basis. In general, however, the returns both to capital and to labour are low, particularly when the vicissitudes to which any form of farming is exposed are considered. In no other branch of industry is the result so much at the mercy of climatic conditions. And crop growing and stock raising, the two great branches of farming, are subject to risks other than climatic that do not exist in the case of most other industries. Pests and diseases of plants and animals are always with the farmer, and the more highly he farms, and the more valuable and specialized his product, the greater his risks from these causes.

The return on the capital invested in land, buildings, implements, stock, etc., by landlord or tenant is generally on a very low level, while the wages earned by agricultural labourers everywhere are on a definitely lower scale than in any other important industry.

The ultimate dependance of the population of the world for all its food, and most if not all of its clothing, upon agricultural production is recognized, and it is not surprising, therefore, to find that the application of scientific knowledge and the extension of scientific research is being constantly urged and is widely relied upon to put the world's greatest and most essential industry into a better and safer condition. During the course of the Imperial Agricultural Research Conference held in London last autumn, it was interesting to note how widely and how strongly this faith was held.

The opinion was freely and frequently expressed that agricultural development in many parts of the Empire was being definitely retarded, or altogether held up, by the lack of sufficient scientific research, and conversely that it was only necessary to initiate such scientific work on a sufficient scale to ensure that existing difficulties would disappear and the desired expansion and success be accomplished. It was interesting, moreover, to note that it was not the scientists themselves who were mainly responsible for this doctrine, or at any rate for its enunciation, but rather the administrators and politicians interested in or responsible for the Conference and the territories represented.

For those of us who are interested in and responsible for some of the schemes of agricultural development in different parts of the Empire, it may not therefore be out of place to discuss some aspects of the position as it reveals itself today, in an attempt to ascertain how advantage can best be taken of the situation and certain dangers inherent in it be avoided.

It is important that the subject should be viewed clearly, and the writer's intention is more to invite the criticisms and views of workers in the very varied fields of agriculture, rather than to lay down the law as to how the scientist can most effectively assist in the development of agriculture throughout the Empire and the world.

That the belief in the efficacy of scientific research to establish, re-establish, or maintain agriculture on a successful basis is widely held by responsible authorities, is evidenced by the increased support which has been forthcoming for agricultural research in many parts of the world.

The present position of agricultural research in Great Britain is particularly interesting in this connection. Coincident with a period of acute agricultural depression has occurred an extraordinary expansion of scientific research in connection with the various branches of home farming. A study of such a document as the "Report on the Work of Research Stations," published by the Agricultural Research Committee, and a glance at the lists given in this report of the publications emanating from the respective stations under review, reveal research activities over such a wide field and on such a variety of subjects that the practical agriculturist almost despairs of the attempt to keep abreast of the work that is going on in Great Britain alone.

In the ten years since the war organizations and institutions connected with agricultural research have widened their scope and intensified their efforts to a remarkable degree, while many new centres of research dealing with one or many of the branches of agricultural work have been created. New laboratories have been built and old ones added to, and both old and new have been equipped in a manner which pre-war workers never dreamt could be possible. The number of scientists engaged in agricultural research has been multiplied, not merely increased, and the conditions under which their work is carried on has been enormously improved. Young and, in many cases, unproved scientists are provided with facilities for work and study, are given a freedom of action and, moreover, a freedom to spend which was unknown to and undreamt of by their predecessors of only a generation ago. There is no question in the present age of the research worker starving unknown in a garret, until such time as the results of his labours bear fruit, and receiving in the end a tardy recognition and beggarly reward for his work.

The dangers, in fact, lie rather in the opposite direction. The greater public interest in scientific work, the more sanguine expectations as to the practical benefits to be obtained from it, and the eager recognition accorded to success, are inclined to force the pace for the worker. The same causes at times result in an over-emphasis of the importance of what may be relatively slight advances in knowledge, and in the publication of results without sufficiently rigid verification and practical test. There is a danger, too, of the limelight now thrown upon scientific research tempting the immature scientist to expose himself and his work before either is sufficiently advanced to stand the glare.

Scientific workers in the past have generally been inspired more by love of their science and interest in the particular subject of their investigation than by any other consideration. Frequently, too, their chief reward was the opportunity, more or less restricted, of pursuing the studies that interested them more than anything else. Now, however, material rewards for scientific success are more assured, and any scientist of quality can find opportunities for the prosecution of his researches under conditions of security and comfort.

These changes may have an effect upon the quality of research work done. Not every scientific graduate is qualified by temperament and other qualities for real research, but such is the repute in which it is held, and so many are the opportunities available, that there is a distinct danger of young workers undertaking research lacking the particular qualities essential for its successful prosecution.

The element of competition, moreover, has definitely entered this field, and is responsible for a certain amount of inferior work. The natural desire to be first in the field with any discovery is at times responsible for a rushing of results, and their publication without that patient and heartless scrutiny to which all additions to scientific knowledge must be subjected and which they must be able to bear.

That splendid work is in progress is undoubted, and that the combined efforts of the various workers will eventually produce great benefits to agriculture is equally certain. The present condition of British agriculture, however, is such as to convey a warning that the scale upon which scientific research is conducted is not alone either a measure or an insurance of the success of the industry in a country. Scientific research will assist the farmer to combat or modify the effects of seasons and the operation of economic laws, but it cannot remove or change these important limiting factors to success.

Accepting the limitations that exist, everyone with any knowledge of the subject must admit the real importance and value of scientific research in connection with agricultural development. Since the opportunities for its prosecution are likely to be much greater in the future than in the past, it becomes a matter of vital interest to consider and decide how scientific work and workers can be utilized to the best advantage in those parts of the Empire in which readers of this journal are most directly interested. These lie mostly in the tropical or subtropical belts, and while sharing some of the problems and difficulties of more temperate regions, have many which are peculiar to themselves, individually or generally.

The foundations of modern agricultural development have generally been laid either by pioneer farmers or planters in regions suitable for white settlers, or by the agricultural services of the different administrations in territories where agriculture is chiefly or entirely a native industry. In both cases there has generally been a basis of native agriculture to work upon. Whereas, however, such native agriculture generally catered for local requirements only, and interest was confined to those food and other products necessary for the family or the tribe, more intensive development of the agricultural resources of these areas has usually been associated with the production of some commodity for export. In some cases the extension of cultivation has been in connection with products already grown by natives. In others, and more generally, it has been associated with some crop or crops new to the district, or which had previously been an unimportant factor in local agriculture.

Rapid expansion of the area of any crop in a particular district inevitably results in a change of balance in local conditions, and brings with it a new series of difficulties and problems. Some of these are social and economic in their nature, and their solution is a task for the local community and the administrative services responsible. With the majority of the problems raised, however, it will be the task of the agricultural services to deal. Towards the speedy and successful solution of many of these, the proper application of scientific knowledge and the proper direction of scientific research will be found essential.

Taken very generally and merely in order to obtain some idea of the nature and degree of the scientific work required, the problems encountered are likely to be such as to entail investigations that can be grouped under three main headings:

1. Botanical.—Maintenance and improvement of the quality of the crops upon which interest is being particularly centred.

Study and interpretation of the reaction of the crops to environment involving close observation of local phenomena, and of the nutrition and development of the plants.

2. Biological.—(*a*) Prevention and/or restriction of insect pests and other organisms causing disease or damage to cultivated crops and live stock.

(*b*) Study of the microscopic fauna and flora of the soil and their relation to its fertility.

(3) Chemical and Physical.—Maintenance and increase of soil fertility.

Taking these rather more fully and in the same order:

1. The maintenance and improvement of the quality of the particular product in question is a task demanding unremitting care and attention. The question of seed supply is of the greatest importance in this connection, and in no crop is this better exemplified than in the case of cotton. Transport charges are a big factor in the cost of putting cotton on the market, and while a relatively small improvement in the length or quality of the staple may mean a considerable enhancement of the value of the cotton, freight and handling charges are the same for the higher grades as for lower qualities. Present knowledge all points to the necessity for the continuous breeding of a pure strain of the variety of cotton most suited to a particular district to form a nucleus of a uniform seed supply for the general commercial crop.

Hand in hand with the work of maintaining a pure supply of seed of the variety in general cultivation must go on a continuous search for others which will give better results either from the point of view of yield or quality or both. This involves careful and repeated testing of all local and other likely strains, and of new types produced by means of scientifically controlled hybridization.

2. (*a*) One result of the change of balance produced in a district by the rapid extension of any particular crop is nearly always brought sharply to the notice of those responsible. That is the increase in the numbers and virulence of insect pests and plant diseases which so generally occurs.

In the case of pests already established in a locality, the increased areas under the crop may provide such assurance of food supply and facilities for reproduction as to enable such pests to get completely away from the control of agencies which have hitherto kept them in check. A new and plentiful source of food supply may also produce a change of habit in insects which previously had not been responsible for serious damage.

Again, there is always present the danger of introducing with a new crop one or more of the pests to which it has been subject in its original locality. Further, in the absence of the natural agencies which may have restricted the spread of such pests in the country of origin, their increase may be very rapid indeed amid new surroundings. The same general dangers exist in connection with diseases produced by organisms other than insects, and in the case of live stock as well as of cultivated crops.

Ability to combat these dangers, to prevent their admission to any district, or to maintain a reasonable check upon them where they exist must depend upon a thorough knowledge of the life history and habits of the insects or other organisms in question, and of all the phenomena associated with their development. Such knowledge must include a full acquaintance with those natural enemies and other factors which tend to exercise a restricting effect upon such development, and of the artificial restrictions that can be practically applied. Where the complete knowledge required does not exist, it can only be obtained by patient research and experiment.

(*b*) Although the general importance of the microscopic fauna and flora of the soil is recognized, the relative effects of the various species and their interrelations are still only imperfectly understood. It can be stated, however, that successful crop production is not possible, unless the conditions in the soil are such as regards texture, moisture content, aeration, temperature, the presence or absence of certain substances, etc., as to provide a favourable medium for the development of certain of these organisms. A fuller knowledge regarding them, and more precise information as to the conditions that favour or restrict their activities, are essential, therefore, to a complete understanding of many of the problems connected with soils and crop production.

3. Questions of the suitability of different soils for particular crops and of variation in soils in reaction to changed methods of cultivation are bound to arise. The application of intensive cultivation to soils that hitherto have been cropped only occasionally or never cultivated at all at once brings up the question of maintaining and increasing fertility. Successful solution of these and similar problems involves detailed study of soil types and of the many components of which the soil is made up.

Although chemical and physical analysis have failed so far to give an accurate measure of the fertility of a soil in relation to a particular crop, a thorough knowledge of the chemical composition and physical nature and condition of a soil is an essential preliminary to any investigation of its productivity and of the means by which this may be restored, maintained, or increased. Not only is such knowledge essential in the preliminary stages, but continuous study is required in order that the reactions of the soil to the changed condition of tillage, cropping, or other treatment may be accurately observed and followed. As a result of such study it may be possible to detect any tendency to deterioration in fertility or condition at a stage where no great harm has been done, and at which the application of remedial measures or a change in practice may prevent further damage or restore the soil to its original fertility.

This admittedly sketchy review of some of the main problems affecting agricultural development in those parts of the Empire in which cotton is or may become an important undertaking should give some idea of the task with which the agricultural services concerned are faced. For such services, individually and generally, the problem becomes one of ways and means; of how the staff and funds available can be utilized to the best advantage and of how more generous provision of both can be justified and obtained. As has been indicated already, there is something of a tendency on the part of responsible authorities to consider that present difficulties can be overcome and future success ensured if only a sufficient number of scientific workers can be concentrated in the various fields. As in most other forms of human activity, however, the application of scientific knowledge and the direction of scientific research to the solution of agricultural problems require very careful planning. And such planning must be done with full knowledge of all the circumstances and clear perception of the real issues at stake, if the desired results are to be obtained and grave disappointment and consequent reaction avoided.

It is just as necessary to preserve a correct perspective in connection with agricultural research as with any other subject, and in consideration of policy in this connection to keep the economic and administrative aspects sufficiently in sight. In one direction particularly does danger lie, and that is in a misunderstanding or misconception of the relations between scientific work and practical agriculture.

" Practice with Science " has been the motto of the premier Agricultural Society of England for something like a century, and undoubtedly the great advance in agricultural science in Great Britain is largely the result of the sensible connection that has been maintained between science and practice in the past.

Not long ago one of our greatest authorities on agricultural science said in regard to British agriculture that science had advanced to the stage of being able to account for the success of the good practice which the observation and experience of farmers had evolved.

Science might be said to be the correct observation and interpretation of natural phenomena, and it is possible for such observation to be exercised without an intimate knowledge of any particular science as commonly understood. Such observation has, in fact, often resulted in the application of scientific principles in ignorance of their existence.

The activities of an agricultural service are mainly divided over two lines of work: field operations, or what is commonly called extension work, and scientific research. Success will largely depend upon the maintenance of a reasonable balance between these two branches of effort, and upon the intelligence displayed in the selection and utilization of field officers and scientific workers respectively. The field officers will be mainly occupied with the general application of approved practice and available scientific knowledge in the extension and improvement of the agriculture of their district. It is in connection with the activities of such officials that most of the problems will be encountered, which it will be the responsibility of the particular agricultural service to deal with. Their ability to observe and correctly appreciate the significance of such problems will be a measure of their value. While such ability will vary considerably with different individuals, its effective exercise must depend to a great extent upon training and previous experience.

Opinions may, and do, vary as to the nature and extent of the scientific training required in the case of these field officers. It may be held that a training in pure science is an essential preliminary, and that instruction in the art and practice of agriculture should be a subsequent part of his course. On the other hand, it is generally accepted that training in agriculture is a first consideration, and that, while a knowledge of the relevant sciences is an essential qualification, specialization in any one branch of science at the expense of his general training does not add to the value or the usefulness of the agricultural officer required for general work.

Whatever the method of training adopted, however, unless it is such as to produce what may be called the sense of good husbandry, it cannot be regarded as a real success. Acquisition of this sense is not a rapid process, and except in the case of a boy brought up in rural and agricultural surroundings, it may be a very difficult one to impart by any method of instruction other than prolonged practical experience.

The scientists in an agricultural service will be called upon to engage in one or both of two main branches of work.

I. The application of ascertained knowledge, where scientific accuracy and a thorough knowledge of technique are essential, as in the case of soil and other analyses, and matters generally of a routine nature.

II. The ascertainment of fundamental information, not otherwise available, by means of work of a research nature.

In the case of scientists engaged in agricultural work, the question of training is not usually regarded as being a matter for much argument, and a degree in pure science is generally the accepted criterion of scientific attainment in the young worker. It is essential, however, that, either during his period of qualifying instruction, or at an early stage in his work, he should obtain something more than a nodding acquaintance with practical agriculture, and acquire an outlook that will enable him to appreciate the practical significance of his particular subject in relation to commercial farming.

The successful utilization of the scientific resources of an agricultural service will depend very largely upon the intelligent allocation of scientific work to one or other of the two categories mentioned above. Having ascertained that a problem exists, and diagnosed its nature sufficiently to realize that it is a matter upon which one or more branches of science must be brought to bear if a solution is to be found, the scheme of action to be adopted must be decided upon.

It may be a problem known elsewhere, and in regard to which the experience of others may indicate a solution. In this case work under Category I.—*i.e.*, the application of available knowledge—will be initiated. If the problem, however, should prove to be a new one, or have features regarding which no information is available, it may be necessary to institute research of a fundamental nature.

A service may be so staffed and equipped as to be in a position to undertake such work at once. If not, it will have to be decided whether the particular researches required must be carried out under the local environment, or whether they could not equally well be undertaken elsewhere at some centre already equipped to deal with the line of work involved.

There is much to be said for the centralization of long-range research work on the lines indicated by the resolutions of the Imperial Agricultural Research Conference regarding a chain of research stations throughout the Empire.

Few if any of the territories under consideration can afford to maintain research institutions capable of dealing with all aspects of the research likely to be required in the solution of their agricultural problems. It is difficult enough to obtain workers of the right type to staff an institution of this kind in the more settled and more temperate parts of the world. It is harder still to find and keep such staff in, say, an African colony, where conditions of life and work are so much less attractive.

It is not always realized how short the real effective working life is in such a situation. Taking the average period of service for pension at, say, twenty-four years, it is interesting to estimate what proportion of this can be devoted to fruitful work. Something like a quarter of the whole service will be spent on leave outside the particular territory. An allowance must be made for other absences from duty, such as sick leave and study leave. The latter is particularly important in the case of a scientist who requires to keep abreast of the advance of knowledge and of technique in his subject. The number of hours per day that can be reasonably devoted to concentrated work is definitely less under tropical conditions than in a temperate climate. Health and fitness, and consequently efficiency, are much more difficult to maintain.

Taking average figures, it will be found that, during a service of twenty-four years, the worker in such a situation will be able to put in something less than half the effective working period possible for his colleague similarly engaged in, say, Great Britain. In view, moreover, of the much longer working life of the latter, the proportion of the effective period is reduced still further. It will be found in fact that it drops to something like a quarter.

There can be no measure of output in connection with scientific research, but, assuming for the purposes of argument that the effective result per working hour is the same in each case, it will thus require four men working under tropical conditions to accomplish the life-work of one engaged on similar lines at home.

Other difficulties, moreover, tend further to reduce the amount of work that can be done. Delays in obtaining essential equipment and material are inevitable, owing to long distances from the sources of supply and difficulties of transport. Continuity of work must be sacrificed at times on account of the necessity for leave or other prolonged absences, unless, of course, a qualified assistant can be provided for every worker. Assistance of a routine nature is much more difficult to obtain, and in fact is often unprocurable, with the result that the research worker has frequently to do himself much that could, and under home conditions would, be carried out quite well by a much less highly qualified assistant.

Other considerations also increase the cost of research work under such conditions. Buildings and equipment are usually much more expensive. Living accommodation must be provided for all classes of workers, adding greatly to the capital cost of any institution.

Agricultural services, therefore, have to consider very carefully the nature and scope of the research work they undertake. Funds are in most cases strictly limited, and the amount that can be devoted to long-range research by individual territories is usually small. It is generally essential, therefore, that work with a direct bearing on local problems, and which is not and cannot be carried out elsewhere, must be the first consideration.

Whatever the programme of research undertaken, it is highly important that a correct balance between this and other forms of activity and a proper appreciation of these latter should be maintained.

The terms " fundamental " and " *ad hoc* " are frequently employed nowadays to differentiate between two types of scientific work. There is some tendency to an over-laudation of fundamental research, and to depreciate the value of the *ad hoc* methods which certain scientific and other members of agricultural services perforce must employ. This attitude is unfair to the latter class of workers, and is apt to discourage them, or to induce them to attempt the more fundamental type of research work, whether they are qualified and equipped for it or not. It must be remembered that it is usually for work of an *ad hoc* nature that they are paid, and which administrations with limited resources immediately demand.

They will, of course, be guided in the direction of their investigations and in the application of scientific principles by the results of fundamental research. Many, if not the majority of problems with which they are called upon to deal, however, demand immediate action, and some of them might be forgotten again before the results of research of a fundamental nature could be obtained.

The above somewhat discursive consideration of the situation leads to certain conclusions which are roughly summarized below. It is hoped that others with experience of the subject will criticize the opinions expressed, and bring forward other points of view which will be of interest and value in connection with the very important question of scientific work in relation to agricultural development.

### CONCLUSIONS SUMMARIZED.

1. That agricultural research has obtained a definite recognition of its value and importance, not only from those connected with the industry, but, and probably more fully, from the general public and the personnel of governments and administrations also.

2. That scientific research is regarded by many responsible authorities as the form of activity upon which the further development of agriculture in many parts of the world mainly depends.

3. That notwithstanding the very wide extension of agricultural research in Great Britain and other European countries, the agricultural industry generally is in a very depressed condition.

4. That in connection with development in those parts of the Empire most concerned with cotton-growing scientific research will

be applied, and will be relied upon to a much greater degree than has been the case in the past.

5. That it is necessary, therefore, to establish such scientific research upon a proper footing, and to maintain a correct balance between it and the other activities of agricultural services, and particularly to concentrate upon a proper direction of research.

6. That problems to be investigated should be correctly diagnosed, and their practical significance clearly understood before action is decided upon.

7. That many of the problems encountered must be attacked by what are known as *ad hoc* methods, because (*a*) immediate action is often necessary; (*b*) facilities and provision for the carrying out of long-range research may not be available.

8. That where it is clear that such long-range research is indicated, it must be seriously considered whether it is essential that this should be carried out under the local environment, or whether it could not be equally well undertaken at some institution already equipped for work of the nature required.

9. That in many of the dependencies and colonies of the Empire research work can only be carried out under conditions that are difficult and unsatisfactory, and which add greatly to its cost.

10. That there is much to be said in favour of the centralization of long-range research work in situations where climatic and other conditions are favourable to steady, concentrated effort and a longer working life than can be expected in many of our territories.

11. That in the application of scientific work to the elucidation of agricultural problems a clear perception of the practical issues must be maintained, and the economic and administrative aspects kept sufficiently in view.

12. That the training of scientists for agricultural work should include such instruction or experience as will ensure an appreciation on their part of the practical side of the industry and of the economic limitations under which it is carried on.

*Received August*, 1928.

# THE COTTON BREEDING STATION, BARBERTON

BY

F. R. PARNELL.

When the Corporation sent Officers to South Africa in 1924, to assist the Union Government with work on cotton, one of the main lines undertaken was the breeding of improved strains of cotton for the Low Veld. An Experiment Station for this purpose was opened by Government at Barberton, under charge of the writer. The first three seasons' plant-breeding work gave very encouraging results, but it was evident that there were other problems of considerable importance that badly needed investigation. Proposals for the expansion of the Station, and a widening of the scope of the work, were discussed with Sir James Currie, Director of the Corporation, on his visit to South Africa last year. These proposals have been accepted by the Corporation, in consultation with the Union Government, and are now being put into effect. It is intended in this article to give a very general account of what has been done up to date and of the new lines of work to be undertaken.

## General Conditions.

Before describing the work, it will be well to mention some of the general conditions in the Low Veld. This cotton-growing area is a long strip of country lying to the east of the Drakensberg escarpment and stretching from north to south through the Eastern Transvaal, Swaziland, Zululand and into Natal, a distance of over four hundred miles.

At some time during the few seasons prior to 1924, cotton had been grown in places scattered over practically the whole length of this area. The results had varied a good deal, but in some places good crops had been obtained over several seasons, and, generally speaking, the plant had grown well everywhere. It was realized that certain areas of low rainfall, especially the lower country on the eastern side, might be subject to failures through drought, but a rapid expansion was predicted and a decided optimism prevailed.

A certain degree of optimism was perhaps justified, but there is no doubt that some of the disquieting factors were commonly overlooked or treated too lightly. The most serious failures had been caused by drought and by two insect pests, bollworm and jassid. Both of these pests, in certain places and seasons, had given some foretaste of what they could do, and it was more than possible that they would become more widespread and severe.

Several varieties of cotton were in general cultivation, representing the survivors of a large number of American Upland varieties that had been introduced and tried at one time or another. As a result of mixing of seed and cross-pollination the surviving varieties were extremely irregular and showed very large variation from plant to plant.

It has been mentioned that the Station at Barberton was opened for the purpose of breeding improved strains of cotton. In general terms, an improved strain of any crop is one that is more profitable to the grower. The additional value may be due to various factors, such as increased yield, better quality of produce, lower cost of production, etc. The more good qualities that can be got together the greater will be the improvement. A preliminary survey was made to see in what direction plant-breeding would be most likely to give useful results.

The varieties of cotton most commonly grown in the area gave a good style of lint, mostly good 1⅛ inches to full 1⅛ inches in staple, a class of cotton that was readily saleable. There was no urgent need for improvement in this direction, though greater uniformity was desirable and the liability to deterioration, a special failing of mixed varieties, had to be guarded against.

By far the most important requirement was an improvement in yield, particularly the average yield over several seasons. There were good prospects of achieving this result, both by increasing ordinary yields and by reducing the number of failures. The existing varieties were capable of giving fair yields in moderately good conditions and in the absence of serious damage by pests. Fruiting, however, was not really good, owing to the mixed condition of the varieties and the fact that they contained a considerable proportion of unthrifty plants. An obvious line of work was to make selections of prolific plants and, from these, to raise new strains in which all the plants would be good yielders.

A still more important point in connection with yield was the very serious damage sometimes caused by jassid. This is a tiny flying insect that breeds on the cotton plant and feeds by sucking juices from the leaves. Different varieties and strains of cotton vary enormously in their susceptibility to jassid, and the plant-breeder can provide an effective control of the pest by breeding strains that are not affected by it. The study of this problem and the breeding of resistant strains has formed the main line of work at the Barberton Station.

### JASSID AND JASSID-RESISTANCE.

The effect of jassid on the cotton plant is to cause the leaves to curl up, change colour and fall off or die. All growth ceases; flowers, buds, and young bolls fall off and large bolls dry up. The plants may die, but they more often remain just alive, leafless and very much dried up. Any bolls that are far from ripe when the attack starts give worthless immature fibre; good lint is obtained only from earlier bolls that are near maturity before the plant is seriously affected. The actual loss of crop depends on the earliness of attack and varies from a negligible amount, where the attack is very late, up to a total loss in cases where the attack develops at a very early stage before any of the bolls are ripe.

The damage caused by this pest varies very considerably from year to year and also from place to place in the same year. It is becoming more and more general throughout the Low Veld, however, and no part of this area can be considered safe from its depredations. There is good reason to believe that considerable damage is caused by it even when the attack is not very noticeable. In some cases farmers have been obliged to give up cotton altogether until such time as seed of resistant strains becomes available.

It has been mentioned above that different varieties of cotton vary in their susceptibility to jassid. One of the first steps was to grow plots, side by side, of all the local varieties, together with a few that had been newly introduced, to see how they behaved towards jassid. Barberton is a good place for doing this, as one can rely on jassid appearing every season. All the varieties were damaged seriously, some more some less, except *Cambodia,* a variety from Southern India introduced by Mr. Lloyd Worrall, an Officer of the Tobacco and Cotton Division who had been investigating jassid-resistance. This variety was practically immune to the pest, but other characters made it unsuitable for general cultivation as it stood. Several promising types have now been bred from it, however, and more may be heard of these at a later date.

The local varieties are all so susceptible as to be badly damaged, but in this respect, as in other ways, they are very mixed and the individual plants vary considerably. Some plants become badly infested and defoliated at a very early stage, before the crop as a whole is much affected; others remain green and comparatively healthy when the surrounding plants have succumbed. Such mixed varieties afford excellent material from which to breed jassid-resistant strains. Full advantage was taken of this, and large numbers of plants were selected from fields of these varieties specially planted for the purpose.

Selections were made at a time when most of the plants were badly affected by jassid, so that resistant plants could be spotted easily. The healthiest of these were examined carefully, and from them were selected such as showed good resistance combined with a heavy crop of bolls and good lint. Each selected plant was picked separately and its seed planted separately in the following season. The resulting plots were examined and compared at frequent intervals and notes were made on all important points, including the uniformity or otherwise of each plot. The selections varied in their susceptibility to jassid, but all showed greater resistance than their parent varieties, and there were many that showed an immense improvement. It was a most encouraging sight to see plots of good selections uniformly green and healthy, when neighbouring plots of the ordinary varieties were brown and leafless. The best lots, taking all the characters into consideration, were retained and new selections were made from them, the less promising lots being discarded. By a continuance of this method, *single plant selection* as it is called, several very useful strains have been produced.

In the ordinary way a plant-breeder is averse from distributing seed of any strain until he has it pure and thoroughly tested. In this case, however, it was of the utmost importance to supply seed of an improved strain for general cultivation at a very early date, otherwise there was a very real danger of cotton-growing being given up entirely over a large part of the Low Veld. It is easier to revive a waning industry than to resurrect it after it is once dead, and, for this reason, every effort has been made to multiply seed as rapidly as possible.

All promising selections that were fairly uniform were multiplied provisionally from the beginning, so that there should be a good quantity of seed to go on with of any that turned out well in the second season. In this manner multiplication and testing have been carried out simultaneously; the good strains have survived in increasing quantity, and the poorer have been discarded or continued in small plots only. The possibility of working this system was due to the fact that the varieties in general cultivation were so susceptible to jassid that almost any resistant strain would be an improvement. Another important point, and a pleasing feature of the whole work, has been the very valuable assistance given by farmers in the different areas. Without such help it would have been quite impossible to attempt the rapid multiplication of seed that has been actually carried out.

At the same time that this multiplication and testing with farmers was being done the usual re-selection and purifying of the strains, together with more detailed and accurate experiments for their testing, were being carried out on the Station. The original, somewhat impure, bulk strains that are going into general cultivation will be replaced later by pure lines of the same strains raised on the Station. The present position is that there are three improved strains of which large quantities of seed are available for planting in the coming season, 1928-29. All the figures are not yet in, so that the actual amount cannot be given, but a total of something like 200 tons of seed should be obtained. This will be planted at a lower seed-rate than is usual, and should cover about 40,000 acres. One of these selections, A.12, was raised by Mr. E. T. E. Andrews, a cotton-grower near Barberton, on his own farm; the other two, Z.1 and U.4, were raised on the Station. Z.1 was the first strain multiplied and accounts for the greater part, about 180 tons, of the seed. The amounts of A.12 and U.4 are about 15 tons and 6 tons respectively, these two strains having been selected one season later than Z.1.

All three of the above strains have done well wherever they have been grown. Their most marked feature is jassid-resistance, and it is in places where jassid has been bad that they have shown up most decidedly better than the local varieties. The table given below shows the results of tests, carried out in three separate areas, for comparing these strains with the chief locally-grown variety of each area.

| *Locality.* | *Local Variety.* | | *Yields of Improved Strains.* | | |
|---|---|---|---|---|---|
| | *Name.* | *Yield.* | *U.4.* | *A.12.* | *Z.1.* |
| Barberton .. | Bancroft .. | 335 | 830 | 674 | 687 |
| Swaziland .. | Uganda .. | 544 | 1,055 | 727 | 635 |
| North Zululand | Zululand Hybrid | 431 | 780 | 501 | 505 |

N.B.—Yield is given in pounds per acre of seed-cotton.

U.4 was outstandingly the best in all three places and showed an immense improvement on the local varieties. A.12 and Z.1 showed a greater increase over the local variety at Barberton, where jassid was more serious, than they did in the other two localities, where jassid did not happen to be a big factor. General returns from multiplication plots more than bear out the above results, and in many cases the strains have given fair yields when neighbouring fields of an ordinary variety have been almost a complete failure.* The plots of U.4 have been very strikingly good, even apart from its jassid-resistance, in all places where it has been grown, and it has shown up particularly well where conditions have been poor. Very urgent and insistent applications for seed have flowed in from all directions.

In addition to the increased yield there is also a slight improvement in the cotton produced by these strains. On the official grading they have given full $1\frac{1}{8}$ to $1\frac{3}{16}$ inches in the past season, as compared with good $1\frac{1}{8}$ inches to full $1\frac{1}{8}$ inches for the general run of the ordinary varieties.

A few further points in connection with U.4 should be mentioned. At present it is by no means a pure uniform strain, but, in spite of such irregularity as exists, it stands out as a very free-fruiting and thoroughly efficient type. It comes into bearing quickly and produces a good crop of bolls in a short time, thus taking every advantage of the good spots in a patchy season and being able to recover rapidly from a bad bollworm attack. It produces large numbers of rather small bolls, and this appears to give it an advantage over large-bolled types when the bollworm is severe. The fact of its being somewhat irregular allows of further improvement being made by selection, and it should be possible, in the course of a few years, to obtain from it a thoroughly satisfactory pure strain giving heavy yields of high quality lint.

## FUTURE WORK OF THE STATION.

With the expansion of the Station the facilities for all lines of work will be greatly improved. An increased area of land, roughly 200 acres, will be under cultivation, nearly all of it being good uniform land suitable for accurate experiments. A permanent laboratory is being built and will be provided with all the necessary equipment. With these facilities and an increased staff it will be possible to widen the scope of the work very considerably.

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* This style of difference is shown in the photographs of plots of Bancroft and U.4, grown near together, under the same conditions, in the 1926-27 season, that are given in "Reports received from Experiment Stations, 1926-27," and in Sir James Currie's report on his visit to South Africa in 1927.

Needless to say the plant-breeding will be continued with no diminution of effort, and the more detailed and exact work that is now becoming necessary will be greatly facilitated by the improved conditions. With the larger area of land it will also be possible to carry out the early multiplication of new strains much more efficiently and under closer observation.

The new lines of work to be taken up will be concerned mainly with general farming practices, including a study of rotation crops, and the more practical side of the control of insect pests. The area is very young agriculturally and little is known of the crops that are likely to be successful in the long run. At present cotton is the main extensive crop in common cultivation, with the exception of maize, the ubiquitous *mealie* of South Africa, which, however, is not altogether at home in the Low Veld. There is a tendency to plant cotton continuously on the same land, since too little is known of other crops that might be rotated with it to make them a safe enough proposition to be planted on a large scale. From many points of view this continuous cultivation of cotton is most undesirable, and it obviously cannot go on indefinitely. There is little doubt that if arable farming is to expand in the Low Veld, or even to hold its own, some sound system of mixed farming will have to be adopted. Cotton is the best crop for large-scale cultivation that they have at present, and will probably remain the most important money crop, but other crops are badly needed and will have to be found before the position can be considered in any way satisfactory. It is therefore proposed to carry out experiments with a number of possible rotation crops. Collections of different varieties of these crops, where more than one variety exists, will be planted for comparison in order to make sure of getting the best material for trial. Different methods of treatment—*e.g.*, time and manner of planting, harvesting, etc.—will be tried and the effects of different types of season will be noted. The general idea will be to see which crops are best suited for rotation with cotton in the conditions prevailing, and to work out some regular system under which they can be grown to the best advantage.

During the course of this work information and experience will be gained of different methods of cultivation, soil-treatment, etc., that should be of value in helping to improve the general standard of farming. One of the biggest problems the farmer has to face in this area is drought, which may occur at any time during the season. The first obvious method of meeting this is to grow drought-resisting crops, and this is recognized by the farmer, especially when he sees his cotton come smiling through a dry spell that ruins his mealies.

There is little doubt, however, that the adoption of better cultural methods is badly needed and would go a long way towards mitigating the evils of drought.

Work on insect pests will be mainly concerned with the bollworms, with possibly some attention paid to stainers. The Division of Entomology is engaged in studying the life-histories of these insects, and it is not proposed to undertake fundamental work of that description. Very little is known, however, of bollworms from the agricultural aspect, how they are affected by different farming operations and practices, by the types of rotation crops cultivated, and similar considerations of a practical nature. Information on these points may be of very considerable importance in devising means of control, and it is particularly in such directions that investigations will be made. At the same time any promising methods for the direct control of bollworm will be given a trial on the Station.

The whole question of the value of trap crops requires looking into. In other parts of the world a system of growing maize near cotton is recommended for keeping American Bollworm from the cotton. From casual observations this method does not appear to be effective here, but it has to be tested properly. On the other hand, a method of trapping the early brood of the Red, or Sudan, Bollworm, by growing ratoon cotton and cutting it back as soon as it becomes infested, has given indications of being useful. Here again the method requires to be carefully investigated.

The effect of winter ploughing on the bollworm pupæ hibernating in the soil at the end of the season is an important point on which it may be possible to obtain some information. This operation is not always easy, though it is generally a good practice from a purely agricultural point of view. If it is found to reduce the numbers of bollworm moths appearing in the next season it will be worth while making greater efforts to adopt winter ploughing as a regular practice. It is quite impossible to form an opinion on such points without some information obtained from actual results.

The above are merely illustrations of the type of work intended. It is realized that experiments of this nature on bollworm control will be a difficult matter, but it is hoped that useful information will be collected gradually. The subject is of such importance, and so little is at present known, that almost any information will be valuable.

*Received August*, 1928.

# IRRIGATION AND CROP PRODUCTION

BY

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WITH reference to an article under the above title* in which the author stresses the importance of a summer fallow on the yield of cotton in Egypt, I have had occasion to go over the data on the subject in the Ministry's files, and desire to point out that an error in calculation has crept into the author's results which seems to vitiate his conclusions. He states that in one series of experiments the average yield of cotton after a short fallow was 3·40 kantars per feddan, while after a long fallow it was 4·39. The data in the file of the experiment are as follows:

| *Experiment.* | *Area of Plot.* | *Number of Repetitions.* | *Type.* | *Yield per Type 1st and 2nd Pickings.* | *Yield per Feddan.* | *Remarks.* |
|---|---|---|---|---|---|---|
| | *Square Metres.* | | | *Rotles.* | *Kantars.* | |
| Soil Sterilization, No. 1 .. .. | 500 | 6 | A | 767 | 3·40 | One feddan= 4,200 square metres. |
| | 500 | 6 | B | 788 | 4·39 | |
| | 500 | 6 | C | 803 | 3·56 | One kantar= 315 rotles (seed cotton). |
| | 500 | 6 | D | 789 | 3·50 | |

A simple arithmetical calculation will show that the yield after a long fallow (Type B) is not **4·39,** but **3·50** kantars per feddan.

The figure 788 is *not* an error, because the individual plot yields composing it are recorded in the file as :

| *Plot Number.* | *Area of Plot.* | *Yield.* | | |
|---|---|---|---|---|
| | | *1st Picking.* | *2nd Picking.* | *Total 1st and 2nd Pickings.* |
| | *Square Metres.* | *Rotles.* | | |
| B1. .. .. | 500 | 89 | 5·5 | 94·5 |
| B2. .. .. | 500 | 115 | 6·0 | 121·0 |
| B3. .. .. | 500 | 130 | 9·25 | 139·25 |
| B4. .. .. | 500 | 140 | 8·5 | 148·5 |
| B5. .. .. | 500 | 134 | 8·5 | 142·5 |
| B6. .. .. | 500 | 137 | 5·75 | 142·75 |
| Total .. | 3,000 | 745 | 43·50 | **788·50** |

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* By E. McKenzie Taylor, D.Sc., in THE EMPIRE COTTON GROWING REVIEW Vol. V., No. 2, April, 1928.

Owing to the importance of the matter in Egypt, it seems desirable that this fundamental error should be corrected, more especially so in view of the fact that the results of subsequent experiments on the subject in this country will be published in the near future.

### NOTE BY DR. E. McKENZIE TAYLOR.

I regret that there should have been an error in my article. The whole of the field experiments in connection with the investigations of the summer fallow have been carried out by the Agronomic Section of the Ministry of Agriculture. The Senior Agronomist at that time forwarded to me the results of the experiments, and these were published as received in the Cotton Research Board Annual Report for 1923, pp. 114-116. The results of two further experiments appeared to confirm those which I quoted. The yields in these two further experiments were as follows:

| | *Kantars per Feddan.* | |
|---|---|---|
| | *Experiment II.* | *Experiment III.* |
| Cotton after long fallow .. .. .. | 5·51 | 4·68 |
| Cotton after short fallow .. .. .. | 4·52 | 3·85 |

Since returning to England further results of experiments II. and III. have been forwarded to me. They are as follows:

1925 RESULTS.

| | *Kantars per Feddan.* | |
|---|---|---|
| | *Experiment II.* | *Experiment III.* |
| Cotton after long fallow .. .. .. | 4·75 | 4·33 |
| Cotton after short fallow .. .. .. | 3·95 | 3·50 |

*Received July* 23, 1928.

# THE PURSUIT OF VENGEANCE

BY

W. GILHESPY

Of a truth, my son, that sage of Persia spoke wisely when he said: " The pursuit of vengeance is an exploit for the fool."

That this saying is worthy of meditation I will show to thee by the story of Ghulam Khan, the son of Nasrullah of the Chandio tribe.

Of Baloochistan were they, a worthy sire and a worthy son. Nasrullah owned rich lands on a southern slope, so sheltered from the bitter winds that sweep down from Afghanistan, that his fruit was of the best and among the first to ripen.

Also, because he toiled with wisdom, the level land below his orchards gave unto him rich yield of cotton. With great love he cared for the soil which Allah had given unto him, so that he won the approval of the Merciful and his possessions increased.

Then was the rule of the British extended, bringing with it both blessing and sorrow for our land. On their great horses came they, and dealt firmly with the raiders, who knew no law except the law of the sword, who swooped down from their strongholds to rob travellers.

Thus were the cultivators poor, for traders from the rich plains of Ind feared to come and buy our produce, or bring us the things we lacked until the strong hand of the British seized those robbers and thrust them into the great jails. Moreover, the British made good roads and built bridges, so that merchandise might be carried swiftly by mules and camels.

Then came the *bunnias* from Hindustan, from Sind, from the Punjab, and from Bhawalpoor. Traders are they to the very marrow of their bones, men who make hard bargains and reap great wealth thereby. No longer did the ripe grapes drop from the purple clusters, or were melons thrown to the cattle, the *bunnias* brought cloth and implements and such things as we needed, carrying away rice and fruit and such cotton as was then grown.

Now these *bunnias* are of a caste of Hindus, and by no means like unto the men of Baloochistan, being aliens to the true faith.

Cowardly are they and afraid to fight with the sword, but having nimble wits and much learning, gained in the schools provided by the British.

Among these *bunnias* are many learned and righteous men, who deal uprightly and give freely to the poor. But the traders who came to Baloochistan were rogues and usurers, having great covetousness in their hearts; liars and the sons of liars, thieves who feared to rob with their hands, but cheated with false tongues, holding together in a bond of evil, so that the growers were at their mercy.

Soon they had all the trade and reduced the prices they gave. If one beat them for their wickedness they ran swiftly to the courts of the British, who punished those who had chastised those greedy ones. Moreover, they would buy no more from those who had beaten them, nor from those who would not accept their price. Thus were the toilers at their mercy.

To those who sold them their produce they lent money freely, taking a mortgage on the unsown crop and charging one anna in each rupee for each month. This the foolish growers promised, being men without learning, and not knowing that he who would borrow one hundred rupees must needs pay more than a hundred and eighty when the thirteen months of the year were ended. If one said to them: " My crops failed by reason of the locusts," or " My cotton perished for that there was no rain," those evil ones would smile cunningly, and sweetly say, " What is that between thee and me? Let the debt stand till good fortune be thine, and may thy cotton yield so freely that thy fields shall be like unto the peaks of the Himalayas in snow time."

Thus would the debt grow heavier each year, aye, so heavy that he who borrowed became the slave of him who lent. Then must he needs sell to the wily usurer at such prices as were offered, for none other would buy from him. Being all sons of Shaitan, these evil ones were brothers in heart and purpose.

In one matter they brought prosperity to the farmers, even though they robbed greatly.

" Grow ye much cotton," they said, " and great shall be your reward. Let the level fields produce more cotton and yet more, for now the price is high and will be yet higher." These were true words, even though they came from the lips of liars.

So these men grew more cotton. Chief of these was Nasrullah, who loved the soil he tilled as other men love swift horses or beautiful women. Therefore, knowing naught of those usurers' wickedness, he borrowed money from one Moti Lal and employed more labourers.

He built a dam, so that he could hold much water with which to grow cotton on the rich, level land at the foot of the hills where his peaches grew.

When the usurer came to him for the money he lent, Nasrullah could not pay, nor did Moti Lal press the matter, taking courteous leave with a smile on his lips and great cunning in his heart.

As the wild beast is caught in the net of the hunter, so was Nasrullah caught by the usurer's wiles, caught and enslaved, driven to his grinding toil as the pack bullock is driven by the goad. Nay, the bullock hath rest and peace when his tyrant wearies. Nasrullah had neither rest nor peace.

He struggled on, tending his cotton by day, resting as he might while he guided the water along the channels to feed the crop at night. Ceaseless toil brought him low, fever ate into his bones; sullen shame that his neck should be under the yoke of an unbeliever broke his spirit, so that he died under the burden which kismet had laid upon him.

Ghulam Khan came into his inheritance. My son, it was an inheritance of debt and poverty, of sorrow and slavery. Yet was he young, and in youth the heart is filled with hope. His was the cotton that fetched the highest price at the great mills, for his land was rich and well watered, being at the foot of the hills where they run down almost into the land of Sind.

Ere he had reached middle age he had paid back much money, yet was the debt heavy and grievous. Less had he than the men who toiled for him, yet, because he had greatly loved his father and held his heritage as precious, he toiled and sought not pleasure.

Then an evil *naseeb*—fate—followed him. In the year when the locusts swept the land from Chotian even unto Sharan, Ghulam Khan had sown much green forage for his milch kine and plough bullocks; when the scourge had passed there was not a green blade left nor a leaf on his fruit trees. He could not plough, for he had naught whereon to feed his beasts. All he could do was to turn them loose among the ravines, trusting to Allah to guide them to where some withered tufts might preserve them.

Then followed the drought, the young canes needed water; there was no water, so that they withered and died. Then Moti Lal knew that the cultivator was helpless in his hands and demanded his money.

Ghulam pleaded for time to pay: as well might the lamb plead with the wolf whose fangs are bared for the throat grip. Still he begged for delay, even laying his turban at the feet of that pitiless one—that unbeliever. Aye, because he had promised his dying father to redeem the mortgage and held a promise sacred, he humbled himself before that infidel dog of the plains. When the money-lender spoke scornfully Ghulam Khan turned on him in his wrath.

Surely he would have slain him, but the usurer grovelled at his feet, promising to remit half the debt and to wait for the remainder until the cultivator should call him to receive it. Then he went swiftly to the court with false oaths on his lips, claiming more money than the holding was worth.

That poor cultivator spoke truthfully, admitting all the debts which were true, for he was a faithful follower of the Prophet and scorned falsehood. But Moti Lal brought false books and lying witnesses, so that the judge believed him, giving Ghulam Khan's heritage to that accursed rice-eater of the plains.

His fields and orchards were taken from Ghulam Khan to pay his debts, for such was the law at that time. Now he toiled for others that he might have bread to eat. Often he looked with hungry eyes on the house his father had built, the trees he had planted, and the land he had tilled deeply to grow cotton. Bitterest of all was his unfulfilled promise to his dying father.

There be those whose spirit breaks when their *naseeb* is bitter, saying: " Why should I struggle against kismet ?" Ghulam Khan toiled on because to him toil was sweet, and for that his faith in the Compassionate was strong.

He went away beyond the hills to the north-west, that he might not see the *bunnia's* hirelings in the orchards and fields in which he had played, and where he had carried food and water to his father, toiling in the noontide heat. Still, though his lot was hard, he knew the peace which Allah giveth unto those who bow to His will.

Among strangers he toiled in hope. Spring came with the clean wind that only the mountain folks know. Spring in the orchards of Baloochistan ! The singing of the birds and the music of the rills ! When the vines are robed in green and the peach trees don their garments of pink ! Surely Paradise will have no fairer view for the eyes of the faithful.

He longed for a sight of that which had once been his, and feared to go. Summer came and went, but still he stayed. Then came winter, and with it a mighty longing to look on that which had been his heritage. Better for Ghulam Khan that he had put the temptation aside.

He went. On the heights the cold winds sent the beasts to shelter, but down at the edge of the plain the soil was warm, and Moti

Lal's servants gathered in the pure white cotton bolls. Then did the chill of despair grip the Baloochi's heart, and he gazed on the rich land that should still have been his.

Rage followed despair, and he swore bitterly as he looked upon the cotton fields clad in white, like a bride in her wedding array. Piled high with bales of cotton, a bullock cart passed him, another, and yet another.

"Mine!" he raved, as another cart drew near. "Mine!—all mine! The trees that my father planted, the dam I helped him to build while we panted with thirst. Mine—the land he tended as a mother tendeth her firstborn. The cotton that shall be sent afar to clothe the children of other lands, while I have none to call me 'Father' or to keep my name alive." The creaking of the bullock carts mocked him. The wind blew a wisp of cotton into his face from yet another laden cart. "Mine! And wrested from me by that dog of an infidel! Mine, yet I toil for others while that spawn of hell doth mock my grief! Shall I go hence when I can toil no longer, and roast in Jehannum for a broken promise to the father who loved me? Mine! Mine! Mine! If I may not have them, that perjured unbeliever shall not ride past my grave on a proud horse from Arabistan!"

My son, in that hour the flame of Ghulam Khan's anger consumed his reason and destroyed his faith. In that hour he forgot Allah, nor left his cause in His hands. Therefore was he forgotten of the Just and Merciful.

He resolved to slay the usurer, but first he crossed the orchard that he might pray at his father's grave. As he passed the house where his father and he had been born, one Lutif Ullah, a perjured Mahomedan who had taken service with the usurer, sternly bade him begone.

Better for him that he had remained silent, for reason and compassion no longer dwelt in Ghulum Khan's heart. He turned towards Lutif Ullah, and the words of chiding died on that traitor's lips as he looked on the doom he might not flee.

He laughed, that madman, as his sinewy hands closed on the other's throat, and he laughed again as the life departed. Again he laughed as he flung the unclean thing that had once been a man into a mountain torrent, and they that had known Lutif Ullah saw him no more for ever.

With the death of that false-hearted one the madness left Ghulam Khan, and only a cold, deadly purpose remained. He bowed his forehead in the dust near his father's grave, making there his vow that he would seek revenge; then, forgetting his weariness, forgetting all except vengeance, he set out to slay his foe.

In Quetta he was told that Moti Lal dwelt in Meeraganj, a city of the lowlands, and thither he went in the swift train. There he learnt that the usurer had gone to some distant town, for it was the time of the cotton harvest, and many growers were in the toils of the usurer, even as Ghulam Khan had been.

So the Baloochi worked for a rich Mahomedan of that city, having charge of the coolies who loaded bales of cotton in the boats. This he did because he needed money, also because the police in British India look sternly upon strangers who come loitering there, lest they be thieves.

When Moti Lal returned he walked by the river and saw the man he had defrauded; then did fear clutch his heart and look forth from his eyes. He had returned to Baloochistan, and there he had learned that Lutif Ullah had gone, and all believed that Ghulam Khan had slain him. Also he knew that the Baloochi had sought him in Quetta, and his evil heart had bade him beware.

Ghulam Khan rejoiced when he saw the fear that scorched his enemy's craven soul. For many toilsome days and lonely nights he had gloated over the joy that would be his when, with one swift, upward stroke of the knife, he would pay the debt he owed. Now, when he saw the *bunnia* haunted by dread and knew that his heart had turned to water, he resolved to let him live awhile.

"Aye," he muttered, "I will let him live and suffer ere I slay him, letting fear eat into his shrunken soul, so that he shall die a thousand deaths ere my knife reacheth his black heart. If I slay him now the police may learn of the wrong he hath done me and suspect me. I will wait until I have money, in order that I can escape." So he toiled with a lighter heart, ever seeking opportunity for revenge, ever finding it in letting his enemy live and suffer.

Hearken now, my son, and learn how he who giveth his heart to dreams of vengeance filleth his own cup with sorrow. In his mad desire to torture his enemy, Ghulam Khan had forgotten Moti Lal's cunning. Also he had forgotten, or knew not, the wickedness of those down-country jackals, who twist righteous laws to their own evil purpose.

Moti Lal's servants hid jewellery in Ghulam Khan's house while he worked, then he made a report to the police that he had been robbed, also bringing forward false witnesses to prove that Ghulam Khan had been seen leaving his house in the dark hours. The jewellery was found hidden in the thatch, evil men swore falsely against the Baloochi, and he was sent to the big jail.

There he lay with evildoers, unbelievers, and vile outcasts. He that had climbed the free, clean mountains of Baloochistan now wore fetters, and took orders from the *bunnias* he hated more than the snakes of the jungle. He left the jail with the rage of madness in his heart and in his feet, running swiftly to find Moti Lal. But the moneylender had left Meeraganj, knowing that now his foe would surely slay him. To this city and that he fled, leaving it in terror when he knew that Ghulam Khan followed. Worn and weak with the rage that fired his soul, the Baloochi trailed his enemy. Often he travelled on foot, often he travelled in the train without a ticket, for the plague had come to Meeraganj and the people fled from the stricken city in thousands.

In the midst of death, aye, even as death held out its hand to clutch him, he dealt death. In the surging crowd that crushed through the barriers, trampling the weaker in their mad struggle for safety, the two struggled for a place in the train. Packed like dates in a basket they fought their way into a carriage. Ghulam Khan saw the man who had ruined him, and, gibbering in his fury, his mighty hands closed on the other's throat. Still the crowd, overwhelming the police of the railway, fought their way into the carriage and tore the two apart in their mad rush—the mad Baloochi and the lifeless victim of his insane hatred.

Outside Pharranoor the train was stopped, and British police with British soldiers took command. They locked the people in the train till the doctors had gone through each carriage, sending those whom the plague had seized to the hospital, and those who had died to the burning ghat. Five of those went swiftly, and they who carried them went swiftly, grim fear running by their side. Of the manner of their death none enquired, for each train carried the dying, and those whom the plague slew, even as they fled.

And while Ghulam Khan lay in the hospital, others died around him—not he. For hate was stronger than death and would not let him die. Hate gave him the desire to live, and hate gave him the strength.

Hate sustaineth him. Of the past he knoweth naught. Sight and memory have left him, sleep cometh to him for a brief hour, then hate cometh and sendeth him out on his grim errand. From street to street he goeth, ever seeking him whom he slew, ever groping in a darkness into which the light of reason may never enter.

Verily, my son, he who pursueth vengeance is forgotten of Allah.

# COMPARATIVE COTTON PRICES

BY

JOHN A. TODD, M.A., B.L.

We continue in this issue the usual annual record of cotton prices.

As will be seen from Table I., cotton prices during the season have risen substantially, although there has been practically no change in the level of general prices. This was largely due to the reduction of the American crop from nearly 18 million bales in 1926 to under 13 millions in 1927. Table II. shows the fluctuations of American and Egyptian spot prices during the past season, with the two previous seasons for comparison. The season began with a sharp rise of American, the result of the early Bureau reports which indicated a production well below that of the preceding season, and the advance continued until on September 9th spot cotton in Liverpool touched 12·67d., the highest point of the season. Then came the inevitable reaction due to the market's expectation of considerable restriction of consumption, especially in the U.S.A., and the decline persisted, in spite of the steadiness of the subsequent Bureau reports, until the end of February, 1928, although prices did not drop to the low level of August 8th (9·17d.). They recovered, however, when the half-yearly statistics of the International Cotton Federation showed no material reduction in the rate of world consumption of American cotton, and although substantial restriction did take place later in the season, especially in the United States, it had very little effect on prices, as the market was by this time influenced mainly by the prospects for the coming crop.

The market at first anticipated a larger acreage for 1928, but the fall of prices during the first half of the season gave rise to fears that the 1928 crop would not greatly exceed that of 1927, and prices took an upward turn. When the actual acreage figure appeared on July 9th, however, it was considerably higher than had been expected, and prices again sagged, especially as the earlier crop reports were favourable. The fall continued into the new season with a short-lived recovery following the publication of the Bureau report of August 8th which, although indicating a production of 14,291,000, or about 1¼ million bales in excess of the 1927 crop, was yet much lower than the market expectation of 14,750,000 to 15,000,000 bales.

As regards Egyptian prices, the level was much higher during

1927-28, as a result of the smaller Egyptian crop. The rise did not go so far, however, as in the case of American, and this is shown by the lower trend of the premiums. The prices of other varieties (as given in Table III.) also ruled higher during the season, the trend as usual following very closely that of American.

### TABLE I.—HISTORY OF COTTON PRICES, 1899–1928.

SEASON'S AVERAGES.

| *Season.* | *Liverpool Prices (Pence per Lb.).* | | | | | *Alexandria.* | *American Price of Upland.* | *Year.* | *Index Numbers of General Prices.* |
|---|---|---|---|---|---|---|---|---|---|
| | *Sea Island.* | *Brazil.* | *American.* | *Indian* | *Egyptian.* | | | | |
| | | Pernam Fair | Middling | No 1 Fine Oomra | F G F Brown. | Dols per Kantar | Cents per Lb | | |
| 1899–1900 | 16·7 | 5·06 | 4·87 | 4·40 | 6·81 | 12·28 | 7·60 | 1900 | 100·0 |
| 1900–01 | 16·4 | 5·50 | 5·16 | 4·37 | 6·87 | 13·80 | 9·30 | 1901 | 96·7 |
| 1901–02 | 19·3 | 4·87 | 4·78 | 4·19 | 6·31 | 10·42 | 8·10 | 1902 | 96·4 |
| 1902–03 | *25·00 | 5·57 | 5·44 | 4·47 | 8·44 | 13·65 | 8·20 | 1903 | 96·9 |
| 1903–04 | 28·40 | 5·16 | 6 94 | 5·56 | 8·56 | 16·65 | 12·16 | 1904 | 98·2 |
| 1904–05 | 27·12 | 5·25 | 4·93 | 4·62 | 7·37 | 13·97 | 8·66 | 1905 | 97·6 |
| 1905–06 | 26·38 | 6·23 | 5·94 | 5·00 | 9·25 | 15·99 | 10·94 | 1906 | 100·8 |
| 1906–07 | 36·70 | 6·97 | 6·38 | 4·87 | 10·37 | 19·16 | 10·01 | 1907 | 106·0 |
| 1907–08 | 35·59 | 6·79 | 6·19 | 5·03 | 8·81 | 18·21 | 11·46 | 1908 | 103·0 |
| 1908–09 | 23·39 | 5·84 | 5·50 | 4·94 | 8·44 | 15·46 | 9·24 | 1909 | 104·1 |
| 1909–10 | 32·85 | 8·34 | 7·86 | 6·31 | 13·12 | 23·30 | 14·29 | 1910 | 108·8 |
| 1910–11 | 35·62 | 8·27 | 7·84 | 7·03 | 10·75 | 20·66 | 14·69 | 1911 | 109·4 |
| 1911–12 | 23·73 | 6·70 | 6·09 | 5·63 | 9·56 | 17·25 | 9·69 | 1912 | 114·9 |
| 1912–13 | 25·00 | 7·11 | 6·76 | 6·16 | 9·79 | 18·28 | 12·20 | 1913 | 116·5 |
| 1913–14 | 23·47 | 7·47 | 7·27 | 5·88 | 9·45 | 19·02 | 13·49 | 1914 | 117·2 |
| 1914–15 | 22·00 | 5·71 | 5·22 | 4·46 | 7·34 | 12·01 | 7·94 | 1915 | 143·9 |
| 1915–16 | 27·00 | 8·22 | 7·51 | 6·09 | 10·42 | 19·28 | 11·99 | 1916 | 186·5 |
| 1916–17 | 50·00 | 13·03 | 12·33 | 10·32 | 21·56 | 37·81 | 18·41 | 1917 | 243·0 |
| 1917–18 | 80·00 | 24·13 | 21·68 | 18·78 | †30·97 | 38·52 | 28·86 | 1918 | 267·4 |
| 1918–19 | 65·00 | 23·96 | 19·73 | 18·13 | 27·85 | 37·20 | 30·36 | 1919 | 296·5 |
| 1919–20 | — | 30 00 | 25·31 | 19·23 | 60·34 | 87·81 | 38·21 | 1920 | 365·7 |
| 1920–21 | — | 13·24 | 11·89 | 9·20 | 30·24 | 34·50 | 16·08 | 1921 | 229·7 |
| 1921–22 | — | 11·40 | 11·37 | 9·60 | 19·75 | 34·28 | 17·78 | 1922 | 185·0 |
| 1922–23 | — | 14·62 | 14·92 | 11·14 | 17·29 | 30·71 | 24·06 | 1923 | 185·3 |
| 1923–24 | — | 18·20 | 17·66 | 13·35 | 21·55 | 39·79 | 31·67 | 1924 | 193·6 |
| 1924–25 | — | 14·67 | 13·76 | 11·95 | 29·82 | 39·49 | 24·27 | 1925 | 185·4 |
| 1925–26 | — | 11·09 | 10·77 | 8·97 | 20·05 | 30·47 | 19·88 | 1926 | 172·5 |
| 1926–27 | — | 8 32 | 8·15 | 7·18 | 15·39 | 21·49 | 12·96 | 1927 | 164·7 |
| 1927–28 | — | 11·36 | 11·17 | 9·21 | 19·39 | ‡29·69 | 19·72 | 1928 | §165·1 |

* South Carolina. † F. G. F. Sakel.

‡ Nine months' average. These figures are F. G. F. Brown till 1914, since then composite figures embracing G. F. Sakel, G. F. Ashmuni, and G. F. Brown.

§ Seven months' average.

## TABLE II.—SPOT PRICES OF AMERICAN AND EGYPTIAN COTTON IN LIVERPOOL, ALEXANDRIA, AND NEW ORLEANS ON THE LAST FRIDAY OF EACH MONTH.

| *Month.* | *Liverpool.* | | *Premium per Cent.* | *New Orleans American Middling.* | *Alexandria F. G. F. Sakel.* | *Premium per Cent.* |
|---|---|---|---|---|---|---|
| | *American Middling.* | *Egyptian F. G. F. Sakel.* | | | | |
| 1925–26. | Pence per Lb. | Pence per Lb. | | Cents per Lb. | Dollars per Kantar. | |
| August .. | 12·60 | 28·65 | *128* | 22·25 | 52·00 | *134* |
| September .. | 12·91 | 28·00 | *117* | 22·92 | 47·75 | *108* |
| October .. | 10·35 | 22·75 | *120* | 19·07 | 39·37 | *107* |
| November .. | 10·74 | 19·75 | *88* | 20·05 | 35·62 | *77* |
| December .. | 10·27 | 17·65 | *72* | 20·00 | 32·87 | *64* |
| January .. | 10·63 | 18·25 | *72* | 20·07 | 34·50 | *72* |
| February .. | 10·33 | 17·30 | *68* | 18·95 | 33·00 | *74* |
| March .. | 10·16 | 15·60 | *53* | 18·05 | 30·50 | *69* |
| April .. .. | 9·94 | 16·25 | *64* | 17·90 | 31·25 | *75* |
| May .. .. | 10·33 | 17·10 | *65* | 18·00 | 31·25 | *74* |
| June .. .. | 9·56 | 16·35 | *71* | 17·55 | 30·00 | *71* |
| July .. .. | 10 02 | 16·40 | *64* | 18·69 | 29·87 | *60* |
| 1926–27. | | | | | | |
| August .. | 10·17 | 16·35 | *61* | 18·49 | 30·00 | *62* |
| September .. | 8·43 | 17·25 | *105* | 14·48 | 33·50 | *132* |
| October .. | 6·85 | 14·65 | *114* | 12·27 | 25·75 | *110* |
| November .. | 6·92 | 14·65 | *112* | 12·61 | 26·37 | *109* |
| December .. | 6·89 | 14·10 | *105* | 12·75 | 25·62 | *101* |
| January .. | 7·26 | 13·65 | *88* | 13·20 | 25·25 | *92* |
| February .. | 7·77 | 13·85 | *78* | 14·06 | 26·00 | *85* |
| March .. | 7·82 | 13 35 | *71* | 14·20 | 26·00 | *83* |
| April .. .. | 8·35 | 14·60 | *75* | 14·95 | 28·50 | *91* |
| May .. .. | 8·94 | 16·75 | *88* | 16·06 | 32·37 | *102* |
| June .. .. | 9·08 | 16·95 | *87* | 16·49 | 32·75 | *99* |
| July .. .. | 10·05 | 19·60 | *95* | 18·33 | 37·87 | *106* |
| 1927–28. | | | | | | |
| August .. | 11·15 | 19·45 | *75* | 21 30 | 38·62 | *82* |
| September .. | 11·57 | 18·75 | *62* | 21·56 | 37 00 | *72* |
| October .. | 11·66 | 18·80 | *61* | 20·31 | 37·00 | *82* |
| November .. | 11·14 | 18·35 | *65* | 19·51 | 35·25 | *81* |
| December .. | 11·06 | 17·75 | *61* | 19 92 | 34·25 | *72* |
| January .. | 10·32 | 17·25 | *67* | 17·91 | 33·25 | *86* |
| February .. | 10·40 | 18·25 | *75* | 18·51 | 34·50 | *86* |
| March .. | 10·86 | 20·15 | *85* | 19·27 | 40·25 | *108* |
| April .. .. | 11·61 | 21·15 | *82* | 21·08 | 41·37 | *96* |
| May .. .. | 11·46 | 21·55 | *88* | 20·46 | 41·75 | *104* |
| June .. .. | 12·49 | 21·30 | *71* | 22·63 | 40·75 | *80* |
| July .. .. | 11·73 | 19·70 | *68* | 20·92 | 38·87 | *86* |
| 1928–29. | | | | | | |
| August .. | 10·46 | 18·85 | *80* | 18·58 | — | — |

## TABLE III.—MONTHLY SPOT PRICES OF VARIOUS KINDS OF COTTON IN LIVERPOOL, 1925–28.

ON THE LAST FRIDAY OF EACH MONTH. FROM THE LIVERPOOL COTTON ASSOCIATION'S WEEKLY CIRCULARS.

(*For American in Liverpool and New Orleans—and Egyptian in Liverpool and Alexandria—see Table II.*)

| *Seasons.* | *Egyptian Uppers (F. G. F.).* | *Peru Smooth (Good Fair).* | *Peru Rough (Good Fair).* | *Peruvian Affi (Good Fair).* | *Brazilian Pernam (Fair).* | *West African (Middling).* | *East African (Good Fair).* | *Indian No. 1 Fine (Oomra).* | *Percentage of Indian on American.* |
|---|---|---|---|---|---|---|---|---|---|
| 1925–26. | | | | | | | | | |
| August | 17·90 | 14·40 | 20·00 | 21·00 | 13·15 | 12·50 | 15·40 | 10·85 | *86* |
| September | 18·15 | 14·61 | 22·00 | 20·00 | 13·36 | 12·61 | 15·45 | 11·35 | *88* |
| October | 16·20 | 12·50 | 21·00 | 18·75 | 11·00 | 10·25 | 13·15 | 9·45 | *91* |
| November | 16·15 | 12·94 | 21·00 | 17·50 | 11·19 | 10·44 | 13·40 | 9·45 | *88* |
| December | 14·15 | 12·52 | 21·00 | 15·00 | 10·77 | 10·04 | 13·05 | 8·80 | *85* |
| January | 13·85 | 12·73 | 21·00 | 16·75 | 10·98 | 10·28 | 13·20 | 8·85 | *83* |
| February | 13·30 | 12·33 | 19·00 | 16·00 | 10·58 | 9·88 | 12·75 | 8·40 | *81* |
| March | 12·30 | 11·91 | 16·00 | 14·00 | 10·41 | 9·71 | 12·35 | 8·00 | *79* |
| April | 12·20 | 11·59 | 16·00 | 13·00 | 10·09 | 9·44 | 11·75 | 7·80 | *79* |
| May.. | 12·60 | 12·13 | 15·00 | 13·00 | 10·63 | 9·98 | 12·20 | 8·20 | *80* |
| June | 12·05 | 11·41 | 15·00 | 12·75 | 9·66 | 9·31 | 11·55 | 7·40 | *79* |
| July.. | 12·20 | 11·92 | 14·00 | 12·25 | 10·17 | 9·77 | 11·60 | 8·10 | *81* |
| 1926–27. | | | | | | | | | |
| August | 12·60 | 11·17 | 12·50 | 11·75 | 10·17 | 9·87 | 11·50 | 8·30 | *82* |
| September | 12·25 | 9·48 | 12·00 | 12·25 | 8·48 | 8·18 | 9·90 | 7·15 | *85* |
| October | 10·50 | 8·15 | 11·50 | 10·50 | 7·15 | 6·80 | 8·50 | 6·15 | *90* |
| November | 10·10 | 8·22 | 10·75 | 10 25 | 7·22 | 6·87 | 8·70 | 6·25 | *90* |
| December | 9·80 | 8·20 | 9·50 | 10·00 | 7·20 | 6·80 | 8·60 | 6·25 | *91* |
| January | 10·10 | 8·51 | 9·50 | 10·00 | 7·26 | 7·01 | 8·95 | 6·45 | *89* |
| February | 10·80 | 8·92 | 9·50 | 10·25 | 7·67 | 7·42 | 9·90 | 6·90 | *89* |
| March | 10·45 | 8·86 | 9·00 | 10·50 | 7·86 | 7·36 | 10·00 | 6·80 | *88* |
| April | 11·60 | 9·30 | 9·75 | 10·75 | 8·55 | 8·05 | 10·95 | 7·45 | *89* |
| May.. | 13·10 | 9·89 | 9·25 | 12·00 | 9·14 | 8·64 | 11·55 | 7·95 | *89* |
| June | 13·30 | 10·08 | 9·50 | 12·50 | 9·33 | 8·83 | 11·80 | 8·20 | *90* |
| July.. | 15·10 | 11·05 | 10·00 | 14·25 | 10·30 | 9·80 | 13·30 | 9·00 | *89* |
| 1927–28. | | | | | | | | | |
| August | 15·45 | 12·00 | 11·50 | 15·25 | 11·40 | 10·90 | 14·40 | 9·65 | *87* |
| September | 14·80 | 12·42 | 12·25 | 15·75 | 11·67 | 11·17 | 14·60 | 9·85 | *85* |
| October | 15·20 | 12·41 | 12·00 | 15·50 | 11·66 | 11·16 | 14·35 | 9·70 | *83* |
| November | 14·55 | 11·89 | 12·00 | 15·25 | 11·14 | 10·74 | 13·90 | 9·25 | *83* |
| December | 14·40 | 11·81 | 11·75 | 14·75 | 11·31 | 10·91 | 13·80 | 9·15 | *83* |
| January | 13·35 | 11·02 | 11·50 | 14·75 | 10·52 | 10·12 | 13·00 | 8·50 | *82* |
| February | 13·55 | 11·35 | 11·25 | 15·25 | 10·60 | 10·20 | 13·10 | 8·60 | *83* |
| March | 14·60 | 12·11 | 12·25 | 16 25 | 11·21 | 10·81 | 14·00 | 8·80 | *81* |
| April | 15·55 | 12·76 | 12·75 | 16·50 | 11·86 | 11·41 | 14·80 | 9·40 | *81* |
| May.. | 15·05 | 12·66 | 13·00 | 16·50 | 11·76 | 11·36 | 14·65 | 9·20 | *81* |
| June | 15·30 | 13·69 | 13·50 | 16·50 | 12·79 | 12·39 | 15·70 | 10·00 | *80* |
| July.. | 14·20 | 12·73 | 12·75 | 16·25 | 11·98 | 11·58 | 14·50 | 9·10 | *78* |
| 1928–29. | | | | | | | | | |
| August | 12·80 | 11·52 | 12·00 | 15·25 | 10·77 | 10·37 | 13·05 | 8·05 | *77* |

# NOTES ON CURRENT LITERATURE

## *COTTON IN INDIA.*

517. The "Review of Agricultural Operations in India, 1926-1927," shows that during the year under report the area under cotton fell to 24,976,000 acres as compared with 28,491,000 acres in 1925-26, the estimated yield being 4,973,000 bales. The average yield per acre was 80 lbs. of ginned cotton, as compared with 88 lbs. and 86 lbs. per acre in the two preceding years. The quantity of raw cotton exported was 3,188,000 bales of 400 lb. as compared with 4,173,000 bales in the previous year, and an average of 3,103,200 bales for the preceding quinquennium. The value of cotton goods exported was Rs. 10.75 lakhs.

The Cotton Transport Act and the Cotton Ginning and Pressing Factories Act continue to show beneficial effects on the cottons grown in those States to which the Acts apply; and, in view of the fact that several Indian States have introduced legislation on similar lines to these Acts, a further improvement in the purity and marketing of Indian cottons may be expected. The passing of the Bombay Cotton Markets Bill, which provides for representatives of cotton growers on Market Committees, has led to the establishment of a cotton market, governed by a Market Committee including growers' representatives, at Sanawad in the Holkar State: this market has proved so successful that steps are being taken for the establishment of four more in the near future. The Review contains a comprehensive account of the progress made in the production of improved strains of cotton, and also of the various lines of research which are being conducted at the experimental stations.

518. **East Indian Cotton Crop Forecasts.** (Abstr. from *Int. Cot. Bull.*, vi., 24, 1928, p. 746.) The Supplementary Government Report has added for Madras Presidency 133,000 acres, equal to an anticipated 31,000 bales, and a supplementary report for Bombay Presidency has added 777,000 acres, equal to an anticipated crop of 360,000 bales. These are large additions, which surpassed trade expectations. This year's acreage will be about 24,722,000, against 24,822,000 in the previous year. The anticipated crop for the present season has been fixed at 5,871,000 bales, against 5,025,000 bales in the previous year, making an average yield per acre of 95 lbs. this year.

519. **An Effective Method of Popularizing Agricultural Improvements among Ryots.** By N. S. Kulandaswamy. (*Agr. Jnl. of India*, vol. xxiii., pt. 3, May, 1928, p. 177.) The article begins by describing the various methods that have been tried from time to time, including demonstration plots worked by the Co-operative Credit Societies, where the difficulty proved to be that as the societies exist for the purpose of lending money, such work was foreign to their general constitution, and it was difficult to get it properly taken up. Societies under the title of Co-operative Agricultural Societies were therefore started, "the individuals running the demonstration area to get advances of requisite seed, manure, and wages of coolies from the society. The advances to be returned to the society at harvest, together with a moiety of the extra net profit due to the improvement; but the loss, if any, is not shared by the society." This system was found to give satisfactory results, some of which are shown in tables annexed to the paper.

520. **Madras Dept. of Agric. Digest 67.** March, 1928. Satisfactory progress is reported in the extension of sowing cotton by means of the drill in the Tinnevelly Black Cotton Soil tract. This year over 17,250 acres were sown

by this method, which is cheaper than broadcasting. After sowing with the drill, the seeds are covered with the single blade harrow, and intercultivation can be done with small blade bullock hoes instead of with hand hoes, which must be used if the seed is broadcasted and covered with a country plough. By the use of a drill the seed can be sown evenly and at a uniform depth, and it can be done much more rapidly.

**521.** DIGEST OF THE OPERATIONS OF THE DEPARTMENT OF AGRICULTURE, MADRAS, in April, 1928. *Pempheres* is reported as troublesome on the Coimbatore Station. The final yields for rain-fed cotton add up to 2,476 lbs. of kapas on the red and 1,412 on the black soil (averages of 413 and 235 lbs. kapas per acre).

**522.** AGRICULTURAL IMPLEMENTS SUITABLE FOR THE USE OF THE INDIAN CULTIVATOR. By A. P. Cliff. (*Agr. Jnl. of India*, xxiii., 11, 1928, p. 95.) The first part of this article was abstracted in this Review, vol. v., p. 60. The article is concluded, and its main points summarized in the journal quoted above. The chief implements recommended as calculated to improve native agriculture in India while being, at the same time, simple and cheap, are the Bihar cultivator, ridge plough and ordinary plough. Photographs and descriptions of the implements are given.

**523.** STATISTICAL INFORMATION CONCERNING COTTON SPINNING IN INDIA. (*Int. Cot. Bull.*, vi., 24, 1928, p. 785.) The Manchester Cotton Yarn Association has compiled an instructive pamphlet with the above heading. From this interesting paper we cull the following items of information. The cost of erection of cotton mills has more than doubled since 1914. India is obliged to engage three persons in place of one employed in the Lancashire mills. The hours worked per day are ten, or sixty per week. Wages have more than doubled since 1910.

**524.** TECHNOLOGICAL REPORTS ON STANDARD INDIAN COTTONS. By A. J. Turner. Copies have been received from the Indian Central Cotton Committee of reports on the cottons named below. The particulars include Agricultural Details, Broker's Report, Fibre Particulars, Spinning Tests, and Remarks and Conclusions.

(1) *Umri Bani*—samples from four seasons.

This variety is not a pure strain, but is the nearest approach to pure Bani (*G. indicum*). About 700,000 acres of it are grown annually. Details as to yield are not available. The conclusion drawn from the tests is that this cotton is suitable for 22s-24s warp.

(2) *Punjab-American* 4 *F*.—Samples from four seasons.

A selection from acclimatized Punjab-American, first distributed in 1913. The area under cultivation in 1924-25 was about 1 million acres. The yield of seed cotton is normally about 530 lbs. per acre, but nearly 1,000 lbs. per acre have been obtained from the B.C.G.A. farm at Khanewal. The cotton is described as suitable for 22s warp.

(3) *Punjab-American* 289 *F*.—Samples from four seasons.

A later selection from acclimatized Punjab-American. Grown at the B.C.G.A. farm at Khanewal. Area under cultivation in 1925-26 about 5,000 acres. Yield of seed cotton, about 1,173 lbs. per acre. The counts for which this cotton is considered suitable differ in each of the samples tested, varying from 30s (1925-26 crop) to 40s (1927-28 crop).

(4) *Coimbatore* Co. 1 (*Cambodia* 295).—Samples from five seasons.

A selection from a mixed crop of Cambodia. The samples were grown on the Cotton Breeding Station, Coimbatore. About 1,000 acres altogether were cultivated in 1925-26. Yield of seed cotton per acre 500 lbs. The cotton is described as suitable for 30s to 38s warp.

(5) *Hagari* 25.—Samples from five seasons.

Selection from the local main season Westerns crop. First distributed in 1917-18. Area under cultivation 1926-27, 157,686 acres. Yield of seed cotton, 239 lbs. per acre, at the Experimental Station. Suitable for 24s to 28s warp.

(6) *Dharwar* I. (*Kumpta*).—Samples from five seasons.

A pure line selection from Kumpta, first grown on a field scale in 1914. In 1925-26, 119,000 acres were under seed of known origin. The total area under Dharwar I. is estimated to be 300,000 acres, yielding 60,000 bales. Yield of seed cotton about 300 lbs. per acre. Described as being suitable for 34s warp.

525. Technological Reports on Standard Indian Cottons, 1928. By A. J. Turner. (*Indian Central Cotton Committee, Bull.* 16, *Tech. Ser.* 11, 1928.) Some of these reports have already been referred to, or abstracted. Compare Abstract 190 on p. 175 of this Journal for April last, and Abstract 524 in this number. Other cottons referred to are Gadag I. (Dharwar-American), which is described as usually suitable for 38s warp, though in 1924-25 it was only suitable for 20s, and in 1925-26 for 30s.

Surat 1027 A.L.F. is suitable for 26s-32s warp; Punjab-American 285 F. for 28s-34s warp; Mollisoni and Aligarh A. 19 (Bengals) for 6s-8s; Cawnpore K. 22 for 12s; Bundelkhand J.N.1 for 12s-14s; Cawnpore-American for 28s-34s; Nandyal 14 for 30s-34s; Karunganni C. 7 for 24s-26s.

## *COTTON IN THE EMPIRE (EXCLUDING INDIA).*

526. Empire Cotton. By J. A. Todd. (*Times Trade Supplement*, May 26, 1928.) The author deals first of all with world consumption of cotton and describes how the temporary glut of supplies caused by the American crop of 1926 was rapidly overtaken by increased consumption, which has apparently reached a new high level (when the cotton is obtainable). He emphasizes the point that the United States cannot be relied on to meet such a demand every year, and that other sources of supply, especially those in the Empire, must be developed. The conditions are described in India, the Sudan, and the principal Crown Colonies, and the conclusion is drawn that "in every direction Empire cotton is justifying, though as yet only on a small scale, its claim to fill up the gaps and to fill in the corners of the world's supply of cotton of all kinds, and is therefore doing just what its promoters wanted—helping to smooth out the fluctuations of prices by adding to the possibilities of substitution of Empire cotton for whatever other variety happens from time to time to be the most deficient in supply."

Attention is drawn to the steady increase in the consumption of Empire growths in Lancashire.

527. Speeches at Luncheon Given to the Rt. Hon. Stanley Baldwin, M.P. Manchester (B.C.G.A.), 1928.

528. British Cotton Growing. By J. H. Summerscales. Oldham. F. and G. Pollard, 1928. A short account of cotton cultivation in the Empire.

529. *Queensland Report on Experimental Work on Cotton.* Callide Cotton Research Station. Biloela, 1926-27. The bulk of this report has already appeared in Reports from Experiment Stations, 1926-27. The preliminary part of it gives climatic and other data.

530. Tanganyika: *Cotton.* (*The Standard*, Nairobi, April 21, 1928.) The Director of Agriculture states that figures received from the District Agricultural Officer, Morogoro, show that nearly 95,000 kgs. of cotton seed have been distributed in Morogoro among over 10,500 growers this season, as compared with

39,000 and 4,000 respectively last year. The similar figures for Kilosa are 70,000 kgs. seed among 7,600 growers in 1928, as compared with 42,300 kgs. seed for nearly 2,900 growers in 1927.

531. TANGANYIKA: *Cotton Advisory Board.* A Board has been established to advise Government on the following points:

(*a*) The leasing of ginnery sites, permission to erect ginneries and the granting of sites for pioneer ginneries.
(*b*) The leasing of cotton market sites.
(*c*) The buying of cotton at centres other than leased cotton markets.
(*d*) The conditions for the issuing of ginnery and cotton-buying licenses.

The Board consists of the Director of Agriculture as Chairman, the Secretary for Native Affairs, the Comptroller of Customs, two members nominated by the Tanganyika Ginneries Association, and one member nominated by the Mwanza Chamber of Commerce. The first action taken was the temporary engagement of two European travelling Inspectors of Cotton Markets.

532. UGANDA. The new Agricultural Laboratory at Kampala, costing about £20,000, was opened in June.

1927-28 crop. Up to June 30, 118,606 bales had been forwarded from the various railway stations and ports.

1928-29 crop. Weather conditions are reported to have been good in all districts except in Lango, where excessive rains retarded cultivation and planting.

## *COTTON IN EGYPT.*

533. THE FIFTH ANNUAL REPORT OF THE COTTON RESEARCH BOARD, EGYPT, 1924. (Govt. Press, Cairo. Price P.T. 15.) The report dealing with the work done in 1924 only reached us in July last.

In the Report from the Botanical Section an account is given of the work done during the year on the extraction of pure lines, and some notes are included on the more interesting families. Graders' Reports and Spinners' Reports on selected strains and new types are given also. An investigation is reported on the root system of the plant and other experiments dealing with diseases. The Chemical Sections Report deals mainly with soil temperatures under fallow and under cotton respectively and with the results of further investigations on alkali soils. The Report includes the programmes of all sections for the following season.

534. NEW AND OLD VARIETIES OF COTTON IN EGYPT. By Dr. W. L. Balls. (Abstr. from *Int. Cot. Bull.*, vi., 24, 1928, p. 728.) Dr. Balls points out the great improvement in the organization available for the study and control of cotton-seed supply in Egypt, and goes on to say: "I want to emphasize the point that varietal 'deterioration' is so called and is not real. What happens is merely contamination, even when the original stock of the variety is quite pure. There are two strains of cotton at Giza today which are exactly identical with their ancestors of 1905-07; contamination of these nucleus stocks has been avoided by the application of strict precautions, so that not one single seed of some other variety has ever been mixed with them, nor has any seed used been exposed to natural crossing by foreign pollen. The chances of such contamination by mixture and crossing are far larger than is commonly imagined; figures obtained in last year's investigations indicate that in the open field, with all possible care in ginning and handling the seed, something like 300 rogue plants find their way into every acre sown (or 1 per cent. of the population); and this infection spreads and also is further augmented in each successive year. Again, we showed last year that in the open field during certain weeks of the season there were two or three seeds per thousand which were cross-fertilized by foreign pollen, although the source of

that pollen was a hundred metres away. Thus it becomes humanly impossible to preserve any variety from contamination when it is growing in the fields. The only practical measure is to keep a nucleus stock with laboratory precautions, and each year to renew the bulk supply by rapid propagation from this pure stock. The main essentials of such a system have already been working for some years upon the practically pure Sakel stock of the State Domains Administration, and the Uppers stock of Bushra Bey Hanna.

"Means being thus available for determining the value of a variety—new or old—for preserving it indefinitely, for getting it into the open field and for keeping it reasonably pure when there, it remains to consider what varieties Egypt should grow. In so doing we must remember that agriculture is a business, so that no variety can survive unless its cultivation is profitable. The product of Yield by Price must be adequate, and (from the small grower's viewpoint) a high yield is a safer proposition than a high price; he is sure to get the yield, but he might not get the full market value.

"About seven varieties are needed, and more than this number are grown already; some of the impure commercial varieties will be replaced by pure stocks of similar type.

"The Royal Agricultural Society's 'Maarad' cotton has altered the whole situation as regards Delta varieties. Whether or not it is as good a cotton as Sakel, in spite of its extra length, is immaterial; it is bound to spread rapidly on account of its yield, which has averaged 33 per cent. more than Sakel during three years' trials made in many different localities by our Agronomic Section. It has set a new standard for new and old varieties; even Pillion has a much lower yield. An extensive change-over from Sakel to Maarad would add a million cantars to the Egyptian crop, and even at several dollars off the price of Sakel the small grower would still profit.

"In summary, we may anticipate an increased supply of Sakel types, a further improvement in the quality of existing Sakel, the appearance of as much super-Sakel as the market will take, an extension of 'bread-and-cheese' supplies into Upper Egypt, and a more level supply of ordinary Uppers. Through all these there will be an extension of the same improvement in purity which is already manifest in the present crop as a result of past and present legislation, administration and research."

Dr. Balls adds that new cottons should not be expected to realize their full market value until the market has become accustomed to them and steady bulk supplies can be expected.

535. MAARAD COTTON. By Arno S. Pearse. (*Int. Cot. Bull.*, vi., 24, 1928, p. 731.) "This is the comparatively new variety of cotton which, according to Dr. Balls' statement at the Zurich Conference of June 14, 1928, is destined to become within a few years the predominant variety in the Delta. Spinners are therefore advised to become acquainted early with the spinning properties of this Maarad cotton.

"The following is a description of the variety, part of which has appeared in the International Congress Report of Cairo, 1927 (see papers by Mr. V. Mosseri.)

"*Brief History.*—Maarad cotton is the result of several years' pedigree selection. It is derived from Pima, which is grown in Arizona. Pima owes its origin to mutation from the Egyptian variety Mit Afifi.

"The purification of this variety has been going on since 1918 and began with a small amount of seed. By studying the yield and field records and selecting only those which gave the best yield combined with the most satisfactory gradings, best field reports, earliness, vegetative growth, regularity in height, types of plants, statistical records, etc., strains of Maarad were produced which were distributed to cultivators in Lower Egypt in 1925, 1926 and 1927.

"In 1928, 10,000 feddans (acres) have been cultivated, which should produce over 40,000 cantars or approximately 5,500 bales.

"*Yield.*—Up to the present the yield has been approximately 33 per cent. better than Sakellaridis in the localities where both varieties were grown.

"In the Cotton Variety Tests carried out by the Egyptian Ministry of Agriculture in different localities in the Delta to test the respective yield of cottons at present grown in Lower Egypt, the yield of *seed cotton* produced per feddan by Maarad cotton was better than any other variety, including those of Pillion, Sakel, Nahda, Fouadi, Casulli, etc., the superior average yield of Maarad when compared with Sakel in these tests being 32 per cent. during the last three years.

"Maarad cotton has a creamy white fibre with the lustre equal or even superior to that of Sakel. It is very fine and long and has a ginning outturn about the same as Sakel.

"*Commercial Value.*—With regard to its commercial value, the opinion of the leading commercial firms in Alexandria has always been that Marrad is fine, long, regular cotton with a good colour and excellent appearance, but in some instances it was thought that the strength was not equal to that of the best Sakel.

"*Spinning Reports.*—Spinning reports have been carried out in England, on the Continent and also in America, and have proved conflicting.

"The United States Department of Agriculture, in their reports, state that Maarad cotton is fine, unusually uniform, and has unusual strength, comparing favourably with the best American-grown Pima. Several French and Swiss spinners state that it is as good as, if not better than, very fine Sakel.

"Several spinning reports have been received from England in which the strength of Maarad has turned out to be equal to that of Sakel, especially when spun in the higher counts, but in other tests it has turned out to be weaker.

"The Egyptian Royal Agricultural Society is taking all the necessary steps to keep this variety as pure as possible and also to maintain its cultural and commercial merits, particularly as regards the control of seed.

"The spinners who have used this cotton seem inclined to the opinion that Maarad cotton possesses the qualities required in a fine cotton, with the exception that it has not the full strength of Sakel. That, however, is not a serious objection to every spinner; some prefer length to strength, and certainly all like a lower price, and in view of the much higher yield of Maarad there ought to be no difficulty in offering it at a considerable discount over Sakel."

**536.** MOISTURE TESTS OF EGYPTIAN COTTON. Report prepared by Arno S. Pearse. (Abstr. from *Int. Cot. Bull.*, vi., **24**, 1928, p. 716.) The Report concludes that: "Applying the Manchester Chamber of Commerce Testing House method of calculation, we find that on the average for 1927-28 shipments the industry paid too much. Translating these figures into plain language, we find that the 1927-28 crop contained nearly 5,000 bales of water instead of cotton, for which the industry had to pay about £250,000, an item which ought to be saved."

**537.** CONTROL OF EGYPTIAN COTTON SEED. (*Times Trade Supplement*, June 23, 1928.) Describing the methods in use by the Egyptian Government.

## *COTTON IN THE UNITED STATES.*

**538.** FIELD CROP WORK AT THE GEORGIA COASTAL PLAIN STATION, 1926. By S. H. Starr. (*Georgia Coastal Plain Sta. Bull.* 8 (1927), *Abstr. from Exp. Sta. Rec.* 58, No. 8, 1928, p. 732.) Contains an account of experiments with cotton including fertilizer tests, spacing experiments and methods of application of calcium arsenate to control boll weevil.

**539.** COTTON FERTILIZER EXPERIMENTS. T. S. Buie and J. D. Warner. (*South Carolina Sta. Bull.* 245 (1928), p. 32. Abstr. from *Exp. Sta. Rec.* 59, 1, 1928, p. 35.) The results gave indications that a well-balanced complete fertilizer is required for economical cotton production. Yields were almost in direct proportion to the quantity of nitrogen supplied. Nitrogen was the first limiting factor and was followed by phosphorus, which in liberal applications resulted in increased total yields and earlier crops. Potassium seemed to prolong the productive fruiting period of cotton, although its effect on yields was not so pronounced as those of nitrogen and phosphorus.

**540.** SOUTH CAROLINA EXPERIMENT STATION REPORT, 1927. (Abstr. from *Exp. Sta. Rec.* 58, No. 7, p. 632.) The report contains further descriptions of experiments with cotton in the field. Spacing experiments showed that the number of plants per acre appeared important from the point of view of earliness and total production under boll weevil conditions. Plants fruited about as rapidly during the early weeks of the fruiting period when crowded as when spaced farther apart. Delinting seed with sulphuric acid has been shown to be profitable in increasing the yield. As regards fertilizer tests, experiments have shown that since the growing season has been considerably shortened, owing to the boll weevil, cotton profits most by applications of quickly available forms of nitrogen. The value of phosphorus in producing early fruiting has been shown. The period from flowering to open boll was not materially influenced by increasing the quantity of phosphorus in the fertilizer. The earlier maturity of the crop due to this fertilizer seemed to be caused by stimulation of early fruiting rather than by a hastening of boll development. The report also contains an account of physiological studies of the plant.

**541.** VARIETIES OF COTTON FOR OKLAHOMA. (*Agr. Exp. Sta. Stillwater, Oklahoma, Bull.* 175, 1928.) Contains an account of experiments with different varieties of cotton, and describes their principal characteristics as grown at the station. The varieties mentioned are Acala, Oklahoma Triumph 44, Lightning Express, Half and Half, Delfos, Trice, Rowden, Lone Star, Mebane, Kasch, Cook's Improved, Petty's Toole, Dixie Triumph, Triumph 406 and New Boykin.

**542.** FACTORS AFFECTING THE PRICE OF COTTON. By Bradford B. Smith. (*Tech. Bull. No.* 50, 1928, *U.S. Dept. of Agr.*) A detailed examination of the effects of the size of the crop and the general level of commodity prices upon the price, the value of the crop, the trend of prices, and the next year's acreage. It is shown that if allowance is made for the carry over from the previous season and for the general level of commodity prices, a fairly definite relationship can be established between the price of cotton thus adjusted and the volume of supply. A very close relationship is shown to exist over a series of years between the price of cotton each January, and the cotton acreage harvested each year.

**543.** SURVIVAL OF THE FITTEST IN U.S.A. (*Int. Cot. Bull.*, vi., 24, 1928, p. 765.) An address by Mr. Walker D. Hines, the President of the Cotton Textile Institute, New York, and a well-known organizer. He has no use for the idea of survival of the fittest, pointing out that it would be exceedingly slow in operation, and suggests, as have so many competent authorities, that the solution of the problem is to be found in co-operation and consolidation.

## *COTTON IN FOREIGN COUNTRIES.*

**544.** BRAZIL. REPORT ON THE ACTIVITIES OF THE COTTON DEPARTMENT IN PARAHYBA (NORTH BRAZIL). (*Int. Cot. Bull.*, vi., 24, 1928, p. 628.) Discussing the reasons for the falling off in production.

**545.** MANUFACTURE OF COTTONS IN THE CONGO. (*Times Trade Supplement*, July 7, 1928.) A cablegram from Leopoldville announces that a Congo textile concern has just put into operation the scutching plant of its new cotton-spinning mill. This is said to be the first enterprise of the kind to be started in the Congo. There will shortly be added other departments—*viz.*, weaving, dyeing, and finishing, and ultimately clothing, blankets, lint, and cotton waste will be placed on the market.

**546.** THE TEXTILE INDUSTRY ON THE CONTINENT OF EUROPE. By F. Nasmith. (*Journ. Text. Inst.*, vol. xix., No. 5, May, 1928, p. P. 115.) A description of the up-to-date methods now employed in many parts of Europe.

**547.** COTTON PRODUCTION IN FRENCH WEST AFRICA. (*Int. Cot. Bull.*, vi., 24, 1928, p. 636.) Conditions, owing to lack of rain, in 1926-27 were not favourable. The total crop has not been more than 6,433 tons, as compared with 8,099 in the previous year.

Only half the quantity has been exported, as there has been a big demand for cotton from the natives for home spinning and weaving.

**548.** MEXICAN COTTON MILLS IN 1927. (Abstr. from *Int. Cot. Bull.*, vi., 24, 1928, p. 775.) Mexico has 160 cotton mills, of which 143 were active and 17 idle during the six months ended April 30, 1927.

**549.** PERU: CULTIVATION AND MARKETING OF COTTON. By A. H. Rosenfeld and C. F. Jones. (*Econ. Geog.*, vol. iii., No. 4, Worcester (Mass.), 1927. Abstr. from *Int. Rev. Agr.*, Rome, xix., No. 3, p. 274.) A general description is given of the cotton-growing industry in Peru. All kinds of cotton can be grown under irrigation, the region being almost rainless. Special attention has been given to irrigation works, and in the last few years a number of schemes have been prepared by an American engineer. Irrigation work is preceded and prepared for by other improvements, such as the cultivation of leguminous crops and drainage works. The cost of production varies according to the special conditions of the plantation, the average cost in 1922 being stated to be roughly 7d. to 8d. per lb., including the rent of the land and expenses. The exports amounted to about 457,000 bales of 400 lbs. in 1926-27. Great Britain is the purchaser of 85 per cent. of the production, but the remainder is increasingly directed towards the United States. The Cotton Export Tax represents one of the main sources of revenue for Peru: it is based on the current market price, and thus varies according to the grade of the cotton. The average yield in lbs. of lint is roughly 338 lbs. per acre. The fertilizer employed is almost exclusively guano, which is applied at the rate of 200-250 lbs. per acre. The labourers employed usually live on the plantations, where each has his plot which he may cultivate on his own account, thus adding to the normal pay, which is from 58 to 75 cents a day. It is estimated that the irrigable area suitable for cotton planting cannot be increased above the present area by more than 25 per cent., but it is anticipated that improvement in yield and standardization of the cotton grown will enable the Peruvian product to hold its own.

**550.** RUSSIA: THE COTTON INDUSTRY. (Abstr. from *Int. Cot. Bull.*, vi., 24, 1928, p. 784.) According to a statement by the U.S.S.R., the cotton-spinning mills of Russia have been increased by 287,000 new spindles during 1926-27 and 1927-28, and 397,000 spindles which had been stopped for several years have again started running. 576,000 new spindles are being erected. In spite of the constant increase in the number of the spindles, the output is not sufficient, and about 25 per cent. of the mills have to work on the three-shift system in order to cope with the demand.

As regards looms, there are 193,000 in the country, of which 6,000 are still idle, though it is expected that they will shortly be working.

## *CULTIVATION AND MACHINERY: IRRIGATION, ETC.*

551. COTTON FERTILIZERS. R. W. Hamilton. (*Clemson Agr. Col. S. C. Ext. Bull.* 86 (1928), p. 15. Abstr. from *Exp. Sta. Rec.* 59, 1, 1928, p. 36.) Practical information is given on the principles of fertilizing cotton, sources of materials, plant food needs of cotton, and the preparation and application of fertilizer mixtures for cotton.

552. ILLUSTRATIONS OF THE APPLICATION OF A CRITERION OF THE DEVIATION OF AN OBSERVED FROM RANDOM DISTRIBUTION TO THE PROBLEM OF SEEDLING STAND IN SEA-ISLAND, EGYPTIAN AND UPLAND COTTON. By J. Arthur Harris, George J. Harrison and F. M. Wadley. (*Journal Agric. Res.*, vol. xxxvi., No. 7, p. 603.) In practical agriculture an effort should be made to obtain in each hill planted an adequate number of seedlings to produce a full stand without waste of seed. Hills which contain no seedlings represent (in a field with proper spacing of hills) a waste of potentially productive land. Hills which contain a larger number of seedlings than is required to produce a full stand of suitable plants represent not merely a waste of seed in planting, but result in too dense a stand in some places and necessitate the expense of thinning.

The paper indicates (1) a method for determining the theoretical number of seedlings per hill which should be found if the distribution were determined solely by the proportion of the seeds planted which produced plantlets, and (2) a method of testing the significance of the difference between the observed and the theoretical distributions.

In order to determine the closeness of agreement between any experimentally determined frequency distribution of number of seedlings per hill and the theoretical distribution, some criterion of goodness of fit is required. This paper suggests the use of the $\chi^2$ criterion for that purpose.

The results of a comparison of observed and calculated frequencies of number of seedlings per hill in an extensive series of experimental plantings of cotton on the saline soils of the Gila River Valley at Sacaton, Ariz., show a material excess for the observed frequencies of hills without seedlings and of hills with larger number of seedlings. The application of the $\chi^2$ test to these empirical and theoretical distributions shows that the chance of difference between the two being due to random sampling is, practically speaking, infinitesimal.

553. APPLICABILITY OF PEARSON'S EQUIVALENT PROBABILITY METHOD TO THE PROBLEM OF SEEDLING MORTALITY IN SEA-ISLAND, EGYPTIAN, AND UPLAND COTTON. By J. Arthur Harris. (*Jour. Agric. Res.*, vol. xxxvi., No. 7, p. 615.) Reference is made to the results obtained in the paper abstracted above (No. 552), and indicates methods by which the deviations of the stand from a purely random distribution may be translated into terms of correlation between the fate of the seedlings of the same hill.

The stands obtained in a wide series of experiments show that there is a medium correlation between the fate of the seeds of the same hill. Thus, either extremely localized conditions or random differences in the capacities of the seeds of the various hills for establishing themselves as seedlings play a large rôle in determining variation in seedling stand.

The advantages of this method of attack are twofold. First, it expresses relationships in terms of correlations which are more readily comprehensible than those of large values of $\chi^2$ and almost infinitesimally small values of P. Second, it permits the extension to this field of work of a combination of methods which have heretofore been employed in a wide range of field heterogeneity investigations.

554. A STUDY OF PROBABLE ERROR METHODS IN FIELD EXPERIMENTS. By H. K. Hayes and F. R. Immer. (*Sci. Agr.*, viii. (1928), No. 6, pp. 345-52. Abstr. from *Exp. Sta. Rec.* 58, 9, 1928, p. 827.) The reliability of different probable

error methods was studied at the Minnesota Experiment Station in the light of mathematical expectation. In a part of this study the yields of small plats grown to the same variety of wheat were treated as if they represented data obtained from a study of different varieties grown in replicated plats. Conclusions drawn from separate probable errors calculated for each variety of four plats would have been erroneous in a number of instances, due to the wide deviation of the yields of these varieties from expectation, whereas conclusions drawn from generalized probable errors did not suffer from this defect. No advantage was found in the random arrangement of plats within each replicate over a uniform replication in the single case tested and when compared as in the problem. The deviation from the mean method (Exp. Sta. Rec., 50, p. 229) more closely approximated mathematical expectation than did Student's method in the two comparisons made, although Student's method gave a slightly lower probable error.

Reference is also made to the paper by one of the authors on controlling experiment error in nursery trials (*J. Amer. Soc. Agron.*, xv., 1923, **5**, p. 177).

**555.** THE AGRICULTURAL VALUE OF RAINFALL IN THE TROPICS. By H. Martin Leake. (*Proc. Roy. Soc.*, B., vol. ciii., 1928, p. 82.) This is the original paper on which Dr. Martin Leake's article in our July number was based. The formula is given for obtaining the curve of effective rainfall, as described on p. 217, the data used being records for the unirrigated wheat and cotton areas of the Cawnpore district, for a Barbados sugar estate, and for the Dhulia Experimental Station. The paper already published in July gives a very good idea of the contents of this more scientific publication.

**556.** A NEW SOIL SAMPLER. By A. Kopp. (*Soil Sci.*, **25** (1928), No. 3, p. 236. Abstr. from *Exp. Sta. Rec.*, 58, **9**, 1928, p. 810.) The instrument consists essentially of a steel tube 5 cm. in diameter with 2·5 mm. walls bevelled at the lower end. Two pieces of smaller pipe, constituting a T-piece handle, are welded to the sides of the main tube apparently about 10 cm. from the top. At 4 cm. from the top two diametrically opposite catches or pins are also welded in. A bronze head fitting over the top of the tube and lined with hardwood, antifriction metal, or the like, to protect the top of the tube when the instrument is struck into the soil, is also provided, together with a second cap carrying a screw piston and held in place by cuts engaging the catches or pins. A detachable wrench serves to turn this expelling screw. Cores of a depth of 1 metre may be taken, the layers remaining undisturbed though the cores are said to be somewhat stiffened.

**557.** COTTON CHOPPING MACHINE. (Abstr. from *Int. Cot. Bull.*, vi., **24**, 1928, p. 704.) A cotton-chopping machine is at present being tested in Texas. Mr. Uddenborg, the inventor, has spent fifteen or more years in perfecting the machine for use in thinning sugar beets, and it is said to be very successful for this work. It has been in use about five years in Sweden in the sugar beet fields, and has also been used in Colorado for several years. One man and a team with the machine, it is said, can chop from 16 to 20 acres per day at a cost of approximately $4 per day, or from 20 to 25 cents per acre.

**558.** MOBILE GIN AND PRESS. (*Association Cotonnière Coloniale Bull.* 83, July, 1928, p. 319.) A description, with illustrations, is given of a 2-ton Unic lorry carrying a 4-cylinder Aster motor, coupled with 2·20 h.p. alternator. Current is thus supplied to a gin with its own separate electric motor and a portable Vaultier press capable of producing bales pressed to a density of about 20 lbs. per cubic foot. The press is carried in a tractor and can be assembled in under an hour. The rotary pump is worked by an 8 h.p. motor contained in the body of the press. The lorry with the power unit is separated by about 16 yards from the gin and press, which can thus be set up under a shed if required.

**559.** GINNING MACHINE. (E.P. 287,994, Platt Bros. and Co., and T. H. Bradley.) A Macarthy gin having a single ginning roller comprises an adjustable pendant fixed knife mounted above the horizontal centre of the ginning roller, an angularly movable knife operating on the up-stroke, and a reciprocating pusher board. The movable knife is operated by a crank disc with an adjustable pin on the outside of the frame. A connecting rod is mounted on roller bearings on the pin and pivoted at its other end on an arm also outside the frame.

**560.** COTTON OPENING AND CLEANING MACHINERY: EFFICIENCY. By J. W. Cooper. (*Text. World*, 1928, **73**, 698 and 745. Abstr. from *J. Text. Inst.*, xix., **6**, 1928, p. A. 195). An account of experiments conducted under mill operating conditions to ascertain as nearly as possible the comparative efficiency of each machine used in a certain plant for cleaning raw cotton. Analyses of the waste rom each unit are given and used as the bases of efficiency determinations.

Of the two samples of cotton used in the tests, the drier did not appear easier to clean.

**561.** OPENING. By J. H. Haddock. (*Cotton* (U.S.A.), 1928, **92**, 223-225. Abstr. from *J. Text. Inst.*, xix., **6**, 1928, p. A. 195.) A general discussion of the opening and cleaning practices in England and the progress made in America. The author emphasizes the fact that cotton should be opened and cleaned by the most gentle treatment possible and should be thoroughly opened before reaching the beaters. In the cleaning process the cotton should be dry.

**562.** ALKALI SOIL STUDIES AND METHODS OF RECLAMATION. By P. S. Burgess. (*Univ. of Arizona Agric. Exp. Sta. Bull.* 123.) The paper gives an account in simple language of the origin of both black and white alkali salts in soils and discusses methods of reclamation which have been shown to be theoretically sound and practically workable in the field. An account is also contained of the successful reclamation of alkali soil at the Yuma Valley Experiment Farm by the methods advocated by the author. It is stated that experiments at the Arizona Experiment Station have shown that black alkali chiefly consists of sodium hydroxide and not mainly of sodium carbonate or bicarbonate. The action of gypsum is also discussed in displacing the sodium present in the soil zeolites by a process of base-exchange.

**563.** UTILIZATION OF IRRIGATION WATER AND ITS INFLUENCE ON SOIL COMPOSITION. F. J. Sievers, H. F. Holtz and C. C. Wright. (*Washington Col. Sta. Bull.*, **222** (1927), p. 47. Abstr. from *Exp. Sta. Rec.*, 59, **1**, 1928, p. 18.) The following conclusions are presented:

The alkali soils may be divided into two types, saline and alkaline, the former being a soil containing abnormal quantities of water-soluble salts and the latter a soil containing appreciable quantities of replaceable bases (chiefly sodium). Alkali soils may originate from the parent rock in the natural processes of weathering or from the application of irrigation water containing soluble salts. Alkali may have at least two harmful effects, in that it may accumulate in amounts beyond the tolerance of crop plants and also in that it may cause soils to become puddled and impermeable to the penetration of irrigation water.

**564.** THE SPACING OF THE COTTON PLANT UNDER IRRIGATION. *Ak-Kavakski Experimental Irrigation Station Bull.* **3**, 1927, *Tashkent*. Russian with English translation.

**565.** STAPLE STANDARDS AND EUROPEAN SUPER APPEAL BOARDS. (*Int. Cot Bull.*, vi., **24**, 1928, p. 673.)

**566.** COTTON SEED: A CHEMICAL STUDY OF VARIETIES OF. (*Texas Agr. Exp. Sta. Bull.* **374**, 1928.) An analytical report on seventy-three samples of many varioties: the hulls, meats and oils were analyzed. The results showed little difference in the properties of the oil of different varieties of seed and no relationship was found between the weight and size of the seed and its oil content. As a rule, seed with the highest percentage of meats contains the highest percentage of oil.

567. AMERICAN EXPERIENCE WITH THE "SECUNDO" DEFIBRATING MACHINE FOR COTTON SEED. (*Int. Cot. Bull.*, vi., 24, 1928, p. 688.)

## *DISEASES, PESTS AND INJURIES, AND THEIR TREATMENT.*

568. LIGHT TRAPS FOR INSECT CONTROL: PROGRESS REPORT. By P. J. Parrott. (*New York, Empire State Gas and Electrical Assoc.*, October, 1927. Abstr. from *Rev. Appl. Ent.*, xvi., 5, 1928, p. 205.) "The results of the first season's work with light traps in New York showed that while a large variety of species of economic importance was captured, only a few destructive insects were taken in large numbers. All the Lepidoptera, which represented 29·6 per cent. of the season's catch, most of the Coleoptera and Rhynchota, and a smaller percentage of the Diptera and Hymenoptera were injurious species. The traps used in these experiments consisted of a galvanized iron pan with a socket for an electric bulb fastened at the intersection of two metal bails with an iron hook at their point of intersection by which the pan was suspended. A telegraph pole with two cross-arms, each bearing a trap at either end, comprised a complete pole unit for field use. Acetylene lamps were used in some tests in the absence of electric power. Of the ten different types of bulbs used, varying from 25 to 200 watts, those of lower power at 6½ feet often attracted more insects than a slightly stronger bulb at 13 feet, and where all the bulbs were at the same power the lower traps were usually more attractive. The addition of baits, such as molasses and water, proved to be a strong attractant, so that a 25-watt frosted bulb, with the addition of a bait, attracted more than double the number of insects captured with a 200 watt clear bulb without bait."

569. COTTON PESTS OF SOUTHERN BRITISH TOGOLAND AND TRANS-VOLTA DISTRICT. By G. S. Cotterell. (*Dept. Agr. Gold Coast Bull.*, 12, 1928). The Bulletin describes experiments at (i) Abor in the Trans-Volta district, (ii) Kpedsu in the Southern plain, (iii) Ve in the area north of the Togoland range. The chief insects attacking cotton in each of the three districts are listed, and their life histories and habits described. Stainers are the most serious pest, but are not so bad in the area north of the Togoland range, where there is greater aridity in the dry season.

South of the range there is a migration of stainers to cotton, but there is no migration north of it. This is believed to be due to the late flowering of cotton in this district, and fruiting commencing after the dry season has set in. The most hopeful control measures are said to consist in the production of late fruiting varieties from the present native cottons. The destruction of Baobab trees is advocated also. Little success has resulted from stainer traps. Owing to the susceptibility of exotic cottons to stainer attack they should not be planted in the south.

570. HOW THE BOLL WEEVIL INGESTS POISON. By E. F. Grossman. (*Florida Sta. Bull.*, 192. Abstr. from *Exp. Sta. Rec.* 58, 8, 1928, p. 760.) Contains an account of the author's investigations into the methods by which the boll weevil accumulates and ingests calcium arsenate and recommendations based thereon as to the most effective methods of applying the poison.

571. THE H-ION CONCENTRATION OF THE SAP OF THE NORMAL COTTON PLANT AND THAT ATTACKED BY THE STEM WEEVIL. By T. Lakshmana Rao. (*Madras Agr. Dept. Year-Book*, 1926. Abstr. from *Exp. Sta. Rec.* 58, 8, 1928, p. 760.)

The preliminary studies here reported indicate an appreciable change in reaction in the plant juice in the direction of alkalinity due to the incidence of disease from weevil attack.

572. PINK BOLL-WORM CAMPAIGN. (*Int. Cot. Bull.*, vi., 24, 1928, p. 665.) Compare July, Abstr. No. 448, p. 277.) The Federal Horticultural Board has recommended, after a series of observations and experiments during several years, the establishment of non-cotton zones in those regions where the presence of the pink worm has been proved. The Commissioner of Agriculture has requested the Congress of the United States for the sum of $5,000,000 in order to compensate the farmers in the non-cultivation of cotton zones, that they intend to establish, and which, according to other information, comprise an area of 467,000 acres.

The finality that is attempted in the campaign, according to the notices mentioned, is to exterminate absolutely this plague from the continent of North America, which will involve not only Texas, but also New Mexico and Arizona, and the Mexican Republic will have to adopt similar measures.

573. LE PINK BOLL WORM AU CONGO. By H. Schouteden. (*Agric. and Elevage Congo belge*, ii., No. 1, p. 1. Abstr. from *Rev. Appl.. Ent.*, Ser. A., xvi., 6, 1928, p. 303.) Pink boll worm has been reported in the extreme east of the Belgian Congo in the Rusisi Valley. The importance of quarantine and fumigation of seed is pointed out.

574. GREECE: INTRODUCTION OF PINK BOLL WORM. (Abstr. from *Int. Rev. Agr. Rome*, xix., 5, 1928, p. 486.) The pink boll worm found its way into Greece in 1925, it is supposed in seed imported from America which was reported to have been disinfected. This seed was distributed throughout the Livadia Province in 1927, and produced a general contamination of the crop, varying from 10 to 60 per cent. The Ministry of Agriculture have formulated a decree forbidding the import of seed in future, except for crushing, in which case it will have to be disinfected. In addition, the transport of seed from infected into uncontaminated cotton-growing areas is forbidden. In Livadia all seed must be disinfected and the plants uprooted and burnt immediately after harvest.

575. RED BOLL WORM (*Diparopsis castanea* (IN SOUTH AFRICA. (*The S.A. Farmer*, May 11, 1928, p. 9). One very interesting and important fact has been established, namely, that the Sudan boll worm will eat through a layer of arsenical poison lying on the boll, without great mortality.

576. NOTES ON THE BIONOMICS OF COTTON STAINERS (*Dysdercus*) IN NIGERIA. By F. D. Golding. (*Bull. Ent. Res.*, xviii., 3, 1928, p. 319.) The several species of *Dysdercus* that have been noted in Nigeria are recorded and a list is given of their alternative food plants in the Ibadan district. There are two forms of *D. superstitiosus* F. in Nigeria (banded and spotted). The banded form appears on cotton earlier in the season than the spotted and remains on the crop longer. Migration to cotton is gradual in the case of the banded form, while a sudden influx of the spotted form commences in October. Many spotted adults migrate to *Bombax* and *Sterculia* between January and March, whereas the banded form remains on cotton until it is uprooted at the end of March. On the other hand, the spotted form is far more numerous than the banded on maize and guinea corn.

Migration to cotton is induced by the flowering of the crop, and the maximum infestation coincides with the period of maximum flowering. There are indications that there is a tendency for stainers to migrate in a southerly direction, probably as a result of the desiccating harmattan wind from the Sahara.

577. NOTES ON COTTON STAINERS (*Dysdercus*) IN THE SUDAN. By J. W. Cowland and W. Ruttledge. (*Bull. Ent. Res.*, 2, xviii., 1927, p. 159.) In the writer's opinion, based, it must be admitted, on but a single year's observations in the Fung and Nuba Mountains Provinces, the three species of *Dysdercus* (*D. fasciatus*, *D. nigrofasciatus* and *D. superstitiosus*) occurring in the northern rain-cotton belt of the Sudan are essentially associates of the tebeldi or baobab tree and are not as yet other than accidental pests of cotton. By this is meant that there is no definite migration from the tebeldi to cotton, nor are wandering adults greatly attracted by cotton. The dispersal of a proportion of the adults composing a colony on a tebeldi is the natural effort on the part of the species to establish itself on other tebeldis. Emigrants from a colony that in the course of their wanderings chance on cotton may remain to breed. It is possible that when cotton has been grown in the district on a large scale for some years, the bugs, unless they are kept in check, may develop the habit of migrating definitely from the tebeldis to the cotton and, later in the season, from the cotton back to the tebeldis.

The most promising line of attack appears to be that of destroying, so far as possible, the colonies on the tebeldis during the active breeding season.

578. COTTON STAINERS (*Dysdercus Sidæ*) IN QUEENSLAND. By E. Ballard and M. G. Evans. (*Bull. Ent. Res.*, xviii., 4, p. 405.) Mr. Ballard, one of the authors of this paper, was formerly the Corporation's Cotton Entomologist in Queensland. The paper is the result of work carried out in two consecutive cotton seasons, and the results published are those obtained up to the end of Mr. Ballard's term of service in Australia. The authors admit that many points connected with the bionomics of *D. sidæ* remain to be cleared up, some of the chief of these being connected with the winter and spring months before migration begins. This will necessitate a study of the life histories of the insect's food plants in the bush, among the principal of which are bottle trees (*Brachychiton rupestris*). The paper contains a description of the various stages of the insect, its egg-laying habits and feeding habits. Its response to climatic changes is dealt with, and it is shown that while a certain amount of atmospheric moisture is necessary for their development, small changes of temperature have a more marked effect than small changes of humidity. Thus drought, excessive rain, and abnormally high and low temperatures all affect the time of arrival of stainers in the cotton fields, which does not appear to depend on the condition of the cotton, though it may be connected with the fruiting of wild food plants.

An interesting description is given by Miss M. G. Evans of migration of stainers witnessed by her. As regards control measures, reference is made to certain parasites, the life histories of which have not yet been studied. No egg parasites have been found. So far under Queensland conditions no satisfactory and economic method of control has been discovered. Heaps of cotton seed, or better, split kernels, will attract nymphs, but the range of their attractive power is small and necessitates very large numbers of such traps. A more hopeful possibility is stated to consist in making use of the gregarious instinct of the fifth instar nymphs when about to moult, by providing suitable collecting places for them, such as slabs of bark, and either destroying them by fire or by some sticky material smeared on the inside of the shelter.

It is hoped to undertake further work by which some of the outstanding points may be cleared up connected with the life history of the insects, the distribution of their food plants of spring and early summer, and the effect of climatic conditions on the food supply and on the time at which it becomes available, and thus the indirect effect of climate on the migration leading to the infestation of the crops.

579. HIBERNATION OF THE COTTON FLEA HOPPER. (*Texas Agr. Ex. Sta. Bull.*, 377, February, 1928.) The hibernation period of the cotton flea hopper at College Station is described as being on the average from October to May 1. Minimum temperatures of 20° F. did not kill dormant eggs. The time at which emergence begins depends mainly on prevailing temperatures, reaching a maximum in mean temperatures of 60° to 62° F. There is a definite relation between the time of maximum emergence and the extent of injury to cotton. Normally the heaviest emergence from hibernation occurs before cotton is usually planted, or at least before much cotton has come up. When climatic conditions delay emergence and cotton is planted at the average date, conditions are favourable for extensive injury to the crop by the flea hopper. The winter host plants of this pest include many of the commonest weeds in Texas.

580. STUDIES OF INSECTS, INSECT PESTS, AND OTHER ANIMALS. (*South Carolina Sta. Rpt.*, 1927, pp. 34-44, figs. 4. Abstr. from *Exp. Sta. Rec.*, 58, 7, 1928, p. 662.) A brief summary is included of work with the cotton flea hopper in continuation of results obtained 1926.

581. SONORA COTTON SQUARE DAUBER (*Creontiades debilis* Van. D.) (*Journ. Econ. Ent.*, vol. xxii., 2, April, 1928, p. 437.) This mirid bug, first observed injuring cotton (Hartsville) in the Yaqui Valley in 1925, proved very destructive in one field of 400 acres (Delfos) in 1927. Present in very small numbers in June, they multiplied on cotton until by August 3 it was estimated that 90 per cent. of the blooms in this field showed effects of the attack. Unlike the usual experience with Egyptian cotton (Pima) in Arizona, where squares fed upon by mirids (*Lygus* spp.) are usually shed, very little shedding of squares occurred. Possibly this retention of injured squares is a characteristic of the cotton variety.

The principal damage was done to young bolls, some of which shed and others continued development in size, but with interiors more or less completely ruined. The damage throughout the Yaqui Valley, where the total plantings were 3,000 acres, amounted to 15 per cent. of the crop.

On September 15 in the same locality where blooms showed that on August 3 90 per cent. had been fed upon in the bud stage, leaving characteristic damage to anthers and spotting of the petals, 92 per cent. of blooms were free from this injury, and the mirids were proportionally scarce.

582. THE QUESTION OF THE ACTION OF ARSENICAL PREPARATIONS IN CONTACT WITH *Locusta migratoria* L. By L. Z. Zakharov. (*Bull. N. Caucas. Pl. Prot. Sta.*, No. 3. Abstr. from *Rev. Appl. Ent.*, Ser. A., xvi., 6, 1928, p. 294.) Experiments to test the contact action of arsenical preparations on *Locusta migratoria* L. were made in large cages in the open. The poisons were applied either by a hand-bellows or by a brush. Sodium arsenite was shown to have a definite contact action, and its effect was increased by the humidity of the air (dew). Calcium arsenate gave indefinite results. The contact action of Paris green was proved provisionally, but further experiments are necessary. On the whole, the experiments were not considered sufficient for definite conclusions.

583. IRAQ: COTTON PROSPECTS, 1928. For the first time in the history of the crop in Iraq there has been a very serious invasion of the migratory locust *Schistocerca peregrina*. The cotton production will undoubtedly depend on the success of the control measures adopted by the Department of Agriculture. Sowings were delayed to a certain extent, since many landowners hesitated to sow until the situation was clearer. In May the Inspector-General of Agriculture gave 4,000 bales as a tentative estimate of the crop.

584. HOW LOCUSTS MAY BE CONTROLLED: SOME USEFUL HINTS FOR SETTLERS. (*East Africa*, vol. iv., 202, August, 1928, p. 1513.) An abstract of a paper in *Bull. Imp. Inst.*, xviii., 2.

585. COTTON DISEASES IN CENTRAL ASIA IN 1926. By N. G. Zaprometoff. (Abstr. from *Rev. App. Myc.*, vol. vii., 6, 1928, p. 374.) One of the chief diseases of cotton in Russian Central Asia is stated to be wilt caused by *Fusarium vasinfectum*. This disease, previously attributed in error to *Neocosmospora vasinfecta*, was much more widespread in 1926 than in 1925. A brief description of the symptoms is given and experiments seem to indicate that the disease is not carried by the seed. Early sown cotton was found to be more liable to the disease than that sown from the end of May onwards.

Investigations carried out on root rot, one of the major diseases in Uzbekistan, showed that this is chiefly caused by mechanical injury to the cotton seedling, followed by invasion by *Penicillium glaucum* and a rod-shaped saprophytic bacterium. In some cases rot was caused by *Rhizoctonia violacea* (*R. crocorum*), which produced symptoms hardly distinguishable from the above.

*Phyllosticta gossypina* caused a brown leaf spot in one locality, and is stated to be the first record of this organism in Central Asia.

586. COTTON WILT: A PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATION. By D. C. Neal. (*Ann. Missouri Bot. Gard.*, xiv., 4, pp. 359-407, 1927. Abstr. from *Rev. Appl. Mycol.*, vol. vii., 5, 1928, p. 320.) A full description of cotton wilt is given, with a review of the literature on this subject.

587. COTTON WILT STUDIES: RELATION OF SOIL TEMPERATURE TO THE DEVELOPMENT OF COTTON WILT. By V. H. Young. (*Bull.* No. 226, June, 1928, *Ark. Agr. Exp. Station.*) Commencing by pointing out the prevalence of this disease upon the lighter soils, the author indicates the desirability of attacking it by some simple soil treatment, and goes on to review the literature from this point of view. The plants were grown in Wisconsin soil-temperature tanks, and soil-temperatures from 28° to 33° C. (and specially those near to 30·5° C.) proved to be the most favourable to the development of wilt. It seems unlikely that below 23° C. or above 35° C. much wilt will develop. Above 28° C. the disease developed in less than twelve days, but below that figure the incubation period was progressively longer. It is suggested that in breeding cottons attention should be paid to varieties that will stand the cold well.

588. THE FUSARIUM DISEASE (WILT) OF COTTON AND ITS CONTROL. By T. Fahmy. (*Phytopath.*, xvii., 11, 1927, pp. 749-767. Abstr. from *Rev. Appl. Mycol.*, vol. vii., 5, 1928, p. 318.) The Fusarium (wilt) of cotton has proved so destructive in Lower Egypt in recent years as to necessitate the substitution of the resistant but less profitable shorter-staple varieties, Ashmouni and Zagora, for the highly susceptible long-staple Sakel. The characteristic symptoms of wilt in Egypt are described, together with the characters of the fungus in the tissues and in culture. Details are given of the optimum temperatures for growth and of the variation of the incubation period with the average day temperature. The relative susceptibilities of the particular varieties of cotton grown in Egypt are also compared. The disease occurs most commonly in heavy, fertile soils, especially where organic manure is applied, in contrast to the disease in America, where it is prevalent on light soils. Results are given of a comparative study of the species of Fusarium causing wilt in Egypt, India and the United States respectively. The differences are considered sufficient to justify the establishment of a new variety of Fusarium for the Egyptian fungus. The only effective measures of control of the disease in Sakel cotton have consisted in the selection of wilt-resistant strains, and it is hoped that by this means a continuous supply of resistant seed will gradually become available to growers.

**589. The Fusarium Disease of Cotton (Wilt) and its Control.** By Tewfik Fahmy. (*Min. of Agric. Egypt, Tech. and Sci. Serv. Bull.* 74, 1928, p. 101.) We extract the summary:

(1) The Fusarium disease of cotton (wilt) has been found to cause considerable damage in the Delta, where Sakel cotton is mostly grown.

(2) The symptoms are given, and are divided into " Internal and External."

(3) The causal organism was isolated and its morphology and cultural characters studied.

(4) The relation between host and parasite and the capacity of the fungus to produce, when grown under artificial conditions, a toxic substance capable of causing seedling cotton to wilt, are given in some detail.

(5) Different varieties of cotton have been tested as to their susceptibility.

(6) The parasite is found to persist in the soil, the infective capacity of which is influenced by various factors.

(7) The Egyptian, Indian and American *Fusarium* parasites producing the wilt disease in the respective countries have been compared and found different in certain characters.

(8) The name *Fusarium vasinfectum var. Egyptiacum* is suggested for the Egyptian parasite.

(9) Methods of control are discussed. Bare fallow is found useless. Soil disinfection with $CS_2$ is considered as impracticable and expensive.

(10) From Domains Sakel cotton, which is susceptible, four resistant strains of Sakel have been isolated and have been grown in heavily infected soil for two consecutive years.

(11) These strains have been graded as Sakel of good quality.

(12) The method for future propagation is given.

## *BREEDING, GENERAL BOTANY, ETC.*

**590. Defruiting as an Aid in Cotton Breeding.** By F. M. Eaton. (*Journ. of Hered.*, xviii., **10**, October, 1927, p. 457.) The prevention of crossing is one of the problems in all breeding work. It is coming to be recognized that nutritional relationships are responsible for much of the boll shedding which is often such a handicap in hand-pollination. Defruiting the plants at intervals was found to reduce boll shedding.

**591. Mendelian Inheritance of Leaf Shape in Cotton.** By R. H. Peebles and T. H. Kearney. (*Journ. of Hered.*, xix., **5**, May, 1928, p. 235.) Segregation in Mendelian ratios is rare in cotton hybrids, and leaf lobation seems to be the only case where it is clearly shown without pronounced predominance of one or the other parental condition. The writers found that it showed in crosses between an okra-leaf form of Acala and the normal, broad-leafed form.

**592. Report on Cotton Breeding and Seed Supply in Nigeria.** Engledow and French. (*E.C.G.C.*, London, 1928.) This report reviews briefly the general cotton situation in the three cotton belts of Nigeria. In the Southern belt the Agricultural Department have produced by selection a strain of native cotton known as Ishan and are now engaged in organizing a system by which Ishan seed can be supplied to the farmers. Both processes are of considerable interest. The Middle belt is at present practically undeveloped as regards cotton. Much exploratory work remains to be done in this area, from which, however, an appreciable quantity of lint might be exported when the most satisfactory type of plant has been determined. In the Northern Belt, Allen cotton has been grown since 1912, and is now the only type of cotton exported. It is not certain, however, whether this type of cotton is the best that could be grown from the point of view of either the farmer or the trade. This matter is being systematically investigated by the Government botanists, and, in the meantime, machinery is being organized in order to multiply and distribute the best possible seed to the farmers. In this area the Empire Cotton Growing Corporation in 1926 established a cotton seed farm where some 220 acres had been cleared and were cultivated last season. The report describes in detail the machinery for multiplying and distributing the seed and also the various methods by which the Corporation's farm can be extended so that on it the amount of pedigree seed required by the Agricultural Department can be multiplied under the careful supervision of the Corporation's staff.

593. A NEW LONG STAPLE COTTON. (*Text. Rec.*, 543, June 15, 1928, p. 40.) It is reported that Mr. George, of Lamarque, Texas, has developed a new cotton of over 1½ inches staple. A Sea Island plant was grafted on to a mulberry tree stock. This was followed by a series of operations involving the pollination and cross-pollination of several different types of cotton. The following season the seed from the first grafting was planted alongside Egyptian cotton, and when the plants blossomed pollen from the Sea Island mulberry type was transferred to the Egyptian blooms. The result was a fibre averaging 1½ inches.

As the Sea Island Mulberry Egyptian cross produced a small boll, in order to obtain a large boll, Mr. George planted the " Hawkins Big Boll " short-stapled American cotton alongside his Sea Island Egyptian cross, and transferred the big boll pollen to his new variety, which produced hundreds of big bolls of the new variety on each plant. These carried from 5 to 9 locks of fine long-stapled cotton on each boll. During the last five years the new cotton has retained its characteristics of length and fineness. The seed is unusually small. Mr. George has named the new type the " Round Ball Everglade American Wonder."

He asserts that with frequent cultivation and fertilization a yield of two bales to the acre can be obtained in the Gulf Coast region when weather conditions are ideal. Without the use of fertilizers and in a dry season both length of staple and yield are reduced.

594. A CONTRIBUTION TO THE CLASSIFICATION OF THE GENUS *Gossypium* L. By G. S. Zaitzev. (*Trans. Turkestan Plant Breeding Sta.*, No. 12, 1928.) The present communication is a preliminary survey of the various forms of cotton, their geographical distribution and their phylogenetic relations. The author promises a more complete monograph on the subject later.

The author claims that the cytological, morphological, physiological and genetical evidence indicates that the genus Gossypium falls phylogenetically into four groups. Of these, two related groups belong to the New World and similarly two to the Old World. The groups of the New World originate from (1) Central America (embracing such species as *G. punctatum* Sch. et Thon., *G. hirsutum* L., *G. mexicanum*, Tod and others), and (2) South America (including such species as *G. barbadense* L., *peruvianum* Cav., *vitifolium* Lam., *brasiliense*, Macf. and others). The groups of the Old World originate from (1) tropical Africa (including *G. herbaceum* L., and some form of *G. obtusifolium*), and (2) Indo-China (including *G. arboreum L.*, *Nanking* Meyen, *obtusifolium* Roxb.).

All groups show a complete parallelism in almost all characters and afford an excellent illustration of the law of homologous series. This parallelism is, however, accompanied by some peculiarities in the characters in separate groups which provide a means of distinguishing them readily from one another. These peculiarities themselves show group parallelism, those of the South American group with those of the Indo-China group, and those of the Central American with those of the African. The so-called " wild " cottons (Section I. of Watt's classification) show physiological and other peculiarities which point to the necessity for separating these forms from the genus *Gossypium*.

An excellent abstract and review of this paper, by Dr. S. C. Harland, appears in *Tropical Agriculture*, August, 1928, p. 200.

**595.** New Cotton Characters from Colombia and Ecuador. By O. F. Cook and J. W. Hubbard. (*Journ. of Hered.*, xix., 4, April, 1928, p. 177.) At Buena ventura in Colombia, two species were found with the buds and young bolls not protected in the usual way by the involucre. It is suggested that this may be correlated with the wet climate. Other peculiarities found in various places included small bracts, bracts with numerous teeth and with overlapping auricles, involucres with prominent nectaries, calyx with auriform crests, carpels with many seeds, seeds naked at base, bolls with two carpels, leaves with two lobes, leaf nectaries reduced, and pubescence of simple hairs.

## *CHEMISTRY AND PHYSICS IN THEIR APPLICATION TO COTTON PROBLEMS.*

**596.** Vitamin-like Substances in Plant Nutrition. J. F. Breazeale. (*Arizona Sta. Tech. Bull.* 16 (1927), pp. 399-417, figs. 2. Abstr. from *Exp. Sta. Rec.*, vol. 58, 7, 1928, p. 618.) From observations upon seedlings, it appears that many plants, in order to develop normally, require certain organic compounds in the soil that are not usually considered as plant foods. These compounds are effective in exceedingly small amounts, and they are necessary in plant nutrition because they are one of the factors that have made the plant what it is today. It is further considered that the benefits both of manuring and of crop rotation consist largely in the addition to the soil of vegetable matter which sets free in its decomposition organic compounds, vitamin-like with respect to the exceedingly small quantities of which they are effective, which are essential to the growth of plants.

**597.** A Chemical Study of the Development of Cotton Bolls and the Rate of Formation of Gossypol in the Cotton Seed. By W. D. Gallup. (*J. Ag. Res.*, 36, 5, 1928, p. 471.) "A study of the change in composition of cotton bolls picked at different stages of development showed that the changes were very rapid from the time the boll first formed until it was ready to open. The young bolls were high in ash, nitrogen, and carbohydrates, and as they matured the fat and crude fibre increased. After the bolls had reached the opening stage their composition was altered slightly by an increase in crude fibre, but from the results presented the nearly mature but unopen bolls will yield products almost as high in their several constituents as the open ones.

The development of oil and gossypol in the cotton seed occurred at about the same time and during a very short and well-defined period of growth. Although it is too early to predict the function of gossypol in the development of the seed, it seems to be associated in some way with the formation of oil. A careful study of all the factors which may influence the growth of the seed, together with an endeavour to increase the oil and decrease the gossypol, is needed."

**598.** The Action of Aluminium, Ferrous and Ferric Iron, and Manganese in Base-Exchange Reactions. By O. C. Magistad. (*Univ. of Arizona Agric. Exp. Sta. Bull.* 18 *of* 1928.)

**599.** A Study of Base Exchange in Soils with the Aid of the Quinhydrone Electrode. F. O. Anderegg and R. P. Lutz. (*Soil Sci.*, xxiv. (1927), No. 6, p. 403. Abstr. from *Exp. Sta. Rec.*, 58, 7, 1928, p. 614.) The conclusions presented include the following: According to the evidence adduced, the base ions replace only one hydrogen from each clay "molecule," the clay behaving like a monobasic acid in contact with the solutions of neutral salts used. The molecular weight of the clay is probably about 3,500 when oven-dried, or about 3,500 when dried in a desiccator at ordinary temperatures. The calculated ionization constants for the sodium, potassium, magnesium, and calcium salts, respectively, of the clay used are represented by the figures 1·70, 1·15, 07·3 and 0·76, each multiplied by $10^5$.

**600.** The Effect of Dehydration of Soils upon their Colloid Constituents. Part I., J. L. Steenkamp. (*Soil Sci.*, xxv. (1928), **2**, pp. 163-182, figs. 7. Abstr. from *Exp. Sta. Rec.*, **7**, 1928, p. 614.) It is concluded in part that the drying of a soil generally increases the solubility of inorganic as well as organic substances, this increase bearing some relation to the temperature of heating. The maximum of soluble constituents was found after heating at about 250° C., higher temperatures causing a decrease in the total salts recovered. The greatest response from drying a soil has been obtained in the case of plants which under natural conditions thrive in soils not subjected to a drying influence in tillage. The data obtained are believed to show that the effect on fertility is traceable to physical, chemical, and biological causes, or combinations of these. Drying is considered to be a powerful factor in the transformation of fertility elements of soils from a potential to an active form.

Part II. (*Soil Sci.*, xxv. (1928), **3**, p. 239. Abstr. from *Exp. Sta. Rec.* 58, **9**, 1928, p. 812.) Continuing the investigations recorded in Part I., the author describes the effect of drying by heat and by exposure to dry atmospheres upon neutral salt-forming and acid salt-forming bases in several soils. A description is given of the manner in which the determinations were made, and the relationship between the data obtained and the moisture content of the soils is illustrated by means of graphs.

**601.** The Volume Weight of Soils as a Physical Characteristic of the Soil Profile. By A. F. Lebedev. (*Soil. Sci.*, xxv. (1928), No. 3, pp. 207-211. Abstr. from *Exp. Sta. Rec.* 58, **9**, 1928, p. 811.) Reasons are given for the view that the weight of a unit volume of soil of undisturbed structure dried at 105° to 110° C. is of considerable importance, both in the description of soil profiles and in the study of soil process dynamics. A description is included of a new design of sampling borer.

**602.** Variations of Water and Dry Matter in the Leaves of Pima and Acala Cotton. R. S. Hawkins. (*Arizona Sta. Tech. Bull.* 17 (1927), p. 417. Abstr. from *Exp. Sta. Rec.* 59, **1**, 1928, p. 35.) An account is given of the methods employed in the determinations and the results obtained from the two varieties are compared.

## *LEGISLATION.*

**603.** India: Cotton Ginning and Pressing Factories Rules, 1925. Notice No. 236-C (24) gives details of the marks required on every bale of cotton. Where three hoops are used the marks are to be stamped on the centre hoop; on either of the hoops if two are used; and on the hoop or on the hessian where one hoop only is used. The following order is to be observed: number denoting factory, letter denoting Province, numerals denoting cotton year.

If the running number also is punched on the hoop, it is to follow the second of the two numbers denoting the year, and separated from it by a star. If stencilled on the hessian, a star is to be placed before and after the running number.

## *MISCELLANEOUS.*

**604.** World's Cotton Production. (From the 1927 Annual Statistical Year Book of the League of Nations. *Int. Cot. Bull.*, vi., **24**, 1928, p. 650).

**605.** Neppiness in Cotton. We have received a letter from Mr. F. Summers, criticizing the article on Neppiness in Cotton which we published in the April number of this journal. His chief contention is that the article is somewhat one-sided, and makes statements which isolated research workers may regard as newly-discovered facts disturbing the accuracy of methods developed at the Shirley Institute by himself and others. Isolated workers, however, should be able to refer to the various original papers published (largely by the Shirley Institute), and to draw their own conclusions. Further research upon this subject is by no means unnecessary.—Ed.

606. Cotton Fabrics and their Uses. (*U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce.*) A useful and extensive list of the uses of cotton in almost every conceivable way.

607. Qualities of Cotton. (*Text. World*, 1928, **73**, p. 1983. Abstr. from *Summ. of Curr. Lit.*, viii., **11**, 1928, L. 15.) The Cotton-Textile Institute (U.S.A.) has published a booklet entitled " Qualities of Cotton " for distribution among manufacturers, distributors, growers, educational and other institutions. The text of the booklet is given. It contains an account of the abundance and economics of cotton, its various uses and specific physical and chemical properties.

608. Cotton Bagging for Cotton. By B. Youngblood. R. J. Cheatham and R. L. Nixon. (*U.S. Dept. Agr., Bur. Agr. Econ.*, 1928, pp. (2)+13, pl. 1. Abstr. from *Exp. Sta. Rec.* 58, **9**, 1928, p. 831.) Four weights of cotton bagging designed and woven specially for experimental purposes were compared with jute in test shipments of cotton. It was reported that the bales covered with cotton bagging were much neater and in better condition generally than those covered with jute. Breaking-strength tests showed that, from all points of view, cotton was a more suitable covering than jute.

609. Photography as a Help in the Examination of Cattle Foods. By W. L. Fielding and S. T. Parkinson. (*Journ. S. E. Agric. Coll. Wye*, No. 25, 1928, p. 155.) On page 160 and in Plates II. and III. of this article are given notes as to the methods of examination of foodstuffs to determine whether they actually contain the cotton seed supposed to be present.

610. Abstracts of Papers on Agricultural Research in Great Britain and Northern Ireland. In this volume the Ministry of Agriculture complete the review of British Agricultural Research work for the Academic year ending September, 1927, the first half of the year's work having been dealt with in a volume circulated to the Imperial Agricultural Research Conference, 1927.

611. Tropical Hygiene. The London School of Hygiene and Tropical Medicine has made arrangements for courses of lectures and practical demonstrations to be given at suitable intervals for the guidance of employees of business firms and other bodies who are about to proceed to tropical and sub-tropical countries, or who, being employed in these countries, are home on leave. These courses of instruction, in addition to providing simple rules for guidance in regard to preparation for life in the tropics and personal hygiene, will also embrace a short account of some of the more common diseases with advice in regard to measures of protection against such diseases, and some guidance in simple methods of self-treatment.

A synopsis of the lectures can be obtained from the Secretary, London School of Hygiene and Tropical Medicine, 23, Endsleigh Gardens, Euston Road, W.C. 1.

612. Botanik und Kultur der Baumwolle. By Ludwig Wittmack. (Abstr. from *Jour. of the Text. Inst.*, vol. xix., **7**, July, 1928, p. P. 182.) A laborious and painstaking summary of information, little of which, however, is new.

613. Empire Marketing Board. From the official abstract sent with the Second Annual Report of the Empire Marketing Board (H.M. Stationery Office, 1s. net), we copy the following items:

The Board states that it "has received much evidence that its work has materially strengthened the demand for Empire produce in the United Kingdom and has definitely increased the sale of particular Empire commodities.

"While it would not claim that the increased importation of Empire products during the last few years has been even mainly due to its own efforts, it is of interest to record that upon the basis of the price levels of 1924, the value of imports from Empire countries to the United Kingdom rose from £386,000,000 in 1924 to £420,000,000 in 1927—an increase of nearly 9 per cent. in a period during which the population is estimated to have increased by 1¼ per cent.

"It is of interest also to record, as showing the growing dependence of employment in the United Kingdom upon the development of the oversea parts of the British Empire, that the value of the exports of British produce and manufactures from the United Kingdom to Empire countries, calculated on the same basis, rose from £334,000,000 in 1924 to nearly £380,000,000 in 1927—an increase of 13 per cent."

RISE IN EXPORTS.—"In 1914 the Empire overseas absorbed 41·7 per cent. of the United Kingdom's export of manufactured goods. In 1927 the percentage had risen to 46·1."

THE PARASITE ZOO.—"In last year's Report an indication was given of the support which the Empire Marketing Board had promised to promote the attack upon insect pests and, through parasites, upon the kindred plague of weeds. During the last twelve months their proposals have taken shape. The Imperial Bureau of Entomology has employed a grant from the Empire Marketing Fund to establish in a Buckinghamshire country house a central laboratory, which has come to be known as the 'Parasite Zoo.' Here are bred parasites that have proved their capacities to destroy certain types of insects, and here experiments are being planned for the testing of parasites of yet unproved capacity. *Already amongst other shipments from this new station parasites of the blow-fly have been shipped to Australia, New Zealand and the Falkland Islands, and parasites of the earwig to Canada.*"

PUBLICITY.—"The Board, at the outset of its work, decided that its main public appeal should be directed less to advertise particular commodities than to interest the public in the Empire and its development, and so create a favourable setting for the activities of those concerned with the sale of individual Empire products. This policy has been confirmed in the light of experience during the last year. *The oversea parts of the Empire have been quick to take advantage of this opportunity of using the background of publicity created by the Board.*"

POSTERS.—"The Board has continued and extended the campaign of poster publicity of which the first steps were recounted in its earlier report. The number of special poster frames has been increased from some 530 in May last to 1,500 in the present month. These frames are now distributed over some 270 towns. They are to be found in almost every town in the United Kingdom with a population of 10,000 or over, and are become familiar to every town dweller. Her Majesty the Queen has been much interested in the posters issued by the Board and has expressed a wish to see each new set as it is issued."

"*In recent months nearly forty members of the British Electrical and Allied Manufacturers' Association have spontaneously provided free sites for these frames in their works: while the same firms, with many others, whose works did not provide convenient sites for the large frames, have asked for special posters, drawing attention to the produce of particular Empire countries, which they desire to exhibit in their shops whenever work upon contracts from those countries is in progress. The Board is now arranging for the erection and posting of a few examples of their frames on prominent sites in the Empire Overseas.*"

LECTURES.—"The scheme of lectures mentioned in the Board's first Report has now been in operation for a year, during which time 2,613 lectures and addresses have been given under the Board's auspices."

# PERSONAL NOTES

## APPOINTMENTS.

### NIGERIA.

Mr. G. Browne has succeeded Mr. J. Dawson Shepherd as officer in charge of the Corporation's Seed Farm at Daudawa in the Northern Provinces, Mr. Shepherd having retired on the completion of his term of service with the Corporation.

The following holders of Senior Studentships last year have received appointments as under:

### NIGERIA.

Mr. H. Hutchinson has been appointed by the Corporation as Assistant to Mr. Browne at Daudawa.

### NORTHERN RHODESIA.

Mr. A. G. Bebbington has been appointed as Cotton Selection Officer at the Government Research Station, Mazabuka, in accordance with the Governor's request that the Corporation would supply an officer for selection work.

### UGANDA.

Mr. H. R. Hosking has secured the post of Assistant Cotton Botanist, Uganda.

### WEST INDIES.

Mr. W. Allan has been appointed Agricultural Entomologist in Jamaica.

## STUDENTSHIPS.

The following have been elected to Studentships under the Corporation for the year 1928-29. The Seniors will hold their Studentships at the Imperial College of Tropical Agriculture, Trinidad, while the Juniors will work at Cambridge University.

### SENIORS.

C. W. L. Fishlock, R. H. Fraser, R. L. Knight, C. W. Lynn, A. Pickles, A. N. Prentice, and R. Turner.

### JUNIORS.

R. P. Davidson, S. T. Hoyle, A. J. Kerr, and E. O. Pearson.

To enable him to undertake a year's Study Leave, a Studentship has been granted to Mr. E. Lawrence, one of the Corporation's Agricultural Officers in Nyasaland. Mr. Lawrence will attend a special course at the Imperial College of Science and Technology.

The special grant made last year to Mr. R. I. Nel, the holder of a scholarship from the University of Stellenbosch, South Africa, has been continued for a further six months, to enable him to complete a piece of entomological research at the Imperial College of Science and Technology.

## OFFICERS ON LEAVE.

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes " home " on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton. The Corporation would consequently much appreciate the courtesy if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would call at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street), immediately opposite to the offices of the Crown Agents for the Colonies.

At the date of writing, the following officers are on leave in England from cotton-growing countries:

| | |
|---|---|
| Gold Coast .. .. .. | Mr. W. H. Beckett. |
| " .. .. .. | Mr. G. C. Coull. |
| " .. .. .. | Mr. F. Pyatt. |
| Nigeria .. .. .. | Mr. J. D. Brown. |
| " .. .. .. | Mr. I. E. James. |
| " .. .. .. | Mr. J. R. V. Smyth. |
| Tanganyika .. .. .. | Mr. J. H. Marshall. |
| " .. .. .. | Mr. C. B. Garnett. |
| Uganda .. .. .. | Capt. J. S. Harmsworth. |
| " .. .. .. | Mr. R. G. Harper. |
| " .. .. .. | Mr. J. D. Snowden. |
| " .. .. .. | Mr. E. G. Staples. |
| Iraq .. .. .. | Mr. D. S. Paterson. |

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